

Operation & Maintains Manual of Weichai Group

Diesel Gen-set

Version No.: V01



Weichai Heavy Machinery Co., Ltd.

Foreword

Before operating the Gen-set, please read this Operation Manual carefully. This user manual is mainly used to guide customers how to use this equipment, describes structural composition, operation and use, daily maintenance and care, fault diagnosis and measures that shall be taken in details, is helpful for operators and maintenance personnel to use and maintain the Gen-set correctly and contributes for judgment analysis and troubleshooting when the Gen-set malfunctions, in order to ensure that the equipment can be put into normal operation rapidly.

Please refer to and read diesel engine's operation manual, alternator's user manual and drawings and documents of control part, etc. provided with the Gen-set whiling reading this manual, in order to prevent accidental operations and misjudgment on faults.

Precautions in this manual are basic principles that the operators must follow and perform strictly. The purpose of safe and effective operation can be realized only if the equipment is operated and maintained correctly. Occurrence of many accidental injuries often is caused by the reason that basic safety rules are not observed.

Contents

Chapter 1 Safety.....	1
I. SAFETY RULES	1
II. SAFETY SYMBOLS	2
Chapter 2 Operating Conditions and Purposes of the Gen-set	5
I. DESCRIPTION ON MODEL OF THE GEN-SET	5
II. DESCRIPTION ON POWER OF THE GEN-SET	5
III. ENVIRONMENT ADAPTABILITY OF THE GEN-SET	6
IV. POWER CORRECTION OF THE GEN-SET	6
V. RANGE OF APPLICATION	7
Chapter 3 Overview on Main Structure of the Gen-set	8
I. DIESEL ENGINE	8
II. ALTERNATOR	8
III. CONTROL PANEL.....	18
Chapter 4 Main Specifications and Technical Parameters of the Gen-set	31
Chapter 5 Transportation of the Gen-set.....	34
Chapter 6 Installation of the Gen-set	35
I. PREPARATIONS BEFORE INSTALLATION	35
II. REQUIREMENTS FOR INSTALLATION OF THE GEN-SET	35
III. STANDARD EQUIPMENT ROOM ARRANGEMENT OF THE GEN-SET	45
Chapter 7 Commissioning of the Gen-set.....	46

I. INSPECTIONS BEFORE COMMISSIONING	46
II. PREPARATIONS BEFORE COMMISSIONING	47
III. COMMISSIONING OF THE GEN-SET	53
Chapter 8 Operation of the Gen-set	58
I. PREPARATIONS AND INSPECTIONS BEFORE OPERATION	58
II. OPERATION OF THE GEN-SET	59
Chapter 9 Maintenance and Care of the Gen-set	64
I. MAINTENANCE AND CARE SCHEDULE	64
II. MAINTENANCE AND CARE OPERATION	65
Chapter 10 Common Failures and Troubleshooting	75
Chapter 11 Service Commitment	92
I. SERVICE CONCEPT	92
II. SERVICE COMMITMENT	92
III. PRINCIPLE AND PROVISION OF QUALITY WARRANTY (“THREE GUARANTEES”).....	92

Chapter 1 Safety

I. Safety rules

Before starting the Gen-set, be sure to read this Operation Manual carefully and know this equipment well. The purpose of safe and effective operation can be realized only if the equipment is operated and maintained correctly. Occurrence of many accidental injuries often is caused by the reason that basic safety rules are not observed. The Gen-set equipment must be operated only by trained electricians. The following rules are provided to remind operators and maintenance personnel of the danger situations that may occur:

1. Electric shock may cause injuries of operators

1.1 Casing of Gen-set must be grounded, in order to prevent endangerment to personal safety of operators caused by live casing. Because Weichai Gen-set is designed with safe grounding system, customers only need to install as per local electric power rules and regulations;

1.2 Do not open cover plate of alternator during operation of the Gen-set, or injuries or even death may be caused by electric shock;

1.3 The air switch shall be turned to switching-off position and the Gen-set shall be stopped when operators perform maintenance on wiring harness of the equipment, or injuries or even death may be caused by electric shock;

1.4 Do not handle electrical failures while wearing wet clothes (especially wet shoes) or having wet skin.

2. Fire hazard may cause injuries or even death of operators

2.1 Open flames and smoking must be prohibited in equipment room of the Gen-set. Battery and fuel of the Gen-set are inflammable, especially lead-acid battery may generate explosive hydrogen when being charged, and may cause personal injuries or even death because hydrogen may immediately cause an explosion if it

contacts with electric arc or spark;

2.2 When the Gen-set is operating or hot, do not add fuel into fuel tank. It would be very dangerous if fuel contacts with hot body of diesel engine and exhaust pipe, etc.

3. Rotating parts may cause injuries or even death of operators

3.1 All rotating parts of Gen-set shall be equipped with protective cover, for example, flywheel, fan and charging alternator, etc. shall be equipped with protective cover. In addition, fastening condition of these rotating parts shall be inspected at a regular interval;

3.2 Do not get close to rotating parts when wearing loose clothes because these would be wrapped in rotating parts and cause personal injuries, or even death;

3.3 Keep your hands away from rotating parts when the Gen-set is operating.

4. High-temperature parts may cause injuries of operators

4.1 Do not open radiator cap when the Gen-set is operating or immediately after the Gen-set is stopped, or splashed high-temperature liquid would cause injuries of operators;

4.2 Do not try to touch exhaust pipe, turbocharger, high-temperature coolant and other high-temperature parts of the Gen-set with your hands when the Gen-set is operating, or your hands would be burnt;

4.3 Owing to the temperature of exhaust pipe is high and in order to prevent burns, the pipe shall be wrapped with heat-resisting materials (e.g. glass fiber or aluminum silicate, etc.), in order to complete thermal insulation. In addition, exhaust terminal and exposed part of exhaust pipe shall be kept away from woods or other flammable substances, especially the fuel piping.

II. Safety symbols

Following safety symbols used on Weichai Gen-set are used to remind operators and maintenance personnel of the fact that serious personal injuries or significant property losses would be caused if they do not follow these warnings. Meanings that these safety symbols express are as shown in Table 1-1.

Table 1-1 Meanings of safety symbols used on Weichai Gen-set

No.	Symbols	Description
1		A warning meaning that there is some immediate danger that may cause serious injuries or even death if cannot be avoided.
2		A warning meaning that there is some potential danger that may cause serious injuries or even death if cannot be avoided.
3		A warning meaning that a potential risk that may cause minor or moderate injuries if cannot be avoided.
4		No lifting
5		No smoking
6		No switching-on
7		Beware of burns

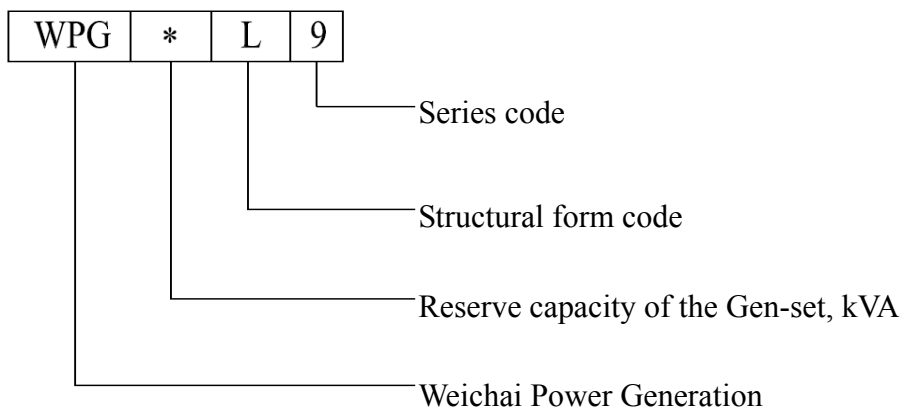
8		Beware of hot surface
9		Beware of electric shock
10		Beware of rotating parts
11		Beware of auto starting
12		Must be grounded
13		Lift up the Gen-set from here
14		Transport with a forklift from here

Chapter 2 Operating Conditions and Purposes of the Gen-set

Diesel Gen-set is a diesel-fueled small-size electro-mechanical power generation equipment in which alternator produces electric energy under driving of diesel engine (prime motor). It converts heat energy (combustion of diesel oil) into mechanical energy (power inverse rotation) and electric energy (AC alternator cuts magnetic field) finally. In this process, fuel is its raw material and electric energy is its product.

I. Description on model of the Gen-set

Model of the Gen-set consisting of four parts is named as per following rules:



II. Description on power of the Gen-set

1. **Rated power:** it refers to the maximum power that the Gen-set is able to provide continuous power supply to variable loads without limitation in annual running time between specified maintenance intervals and under specified environmental conditions.

Its allowable average output power in an interval of 24h shall not be greater than 70% of rated power.

An interval of 1h overload power supply is allowable in every 12h operation of Weichai Gen-set and its overload capacity is 10% of rated output power.

2. **Rated capacity:** for the Gen-set whose power factor is 0.8 (lagging), its rated capacity shall be 1.25 times of rated power.

3. **Reserve capacity:** reserve capacity of Weichai Gen-set is 1.1 times of rated capacity.

III. Environment adaptability of the Gen-set

Under following environmental conditions, the Gen-set shall be able to operate normally and output rated power.

- Ambient temperature: 25°C
- Range of altitude: 0~1000m
- Relative air humidity: 30%~60%

Under non-standard environmental conditions, the Gen-set shall be able to operate normally. But, rated power of the Gen-set must be corrected.

IV. Power correction of the Gen-set

When the Gen-set is going to operate under non-standard environmental conditions, rated power of the Gen-set shall be corrected. If the load power of the Gen-set during operation is greater than corrected rated power, the diesel engine will belch a lots of black smoke and become overheating. If operation like this is kept for a long period of time, diesel engine will malfunction seriously or be damaged, so this situation must be avoided.

When ambient temperature is extremely high, air density would decrease, amount of oxygen provided during combustion of diesel engine will decrease. As combustion efficiency reduces and mechanical output power of diesel engine will reduce accordingly; at the same time, winding needs to be cooled by air during operation of alternator, thus cooling performance will decrease and internal temperature of alternator winding will raise when ambient temperature is extremely high. Therefore, in order to ensure that temperature of alternator winding is kept

within an allowable range, output power of alternator must be reduced.

Air density will decrease also when the altitude increases, thus output of diesel engine and alternator will be affected also.

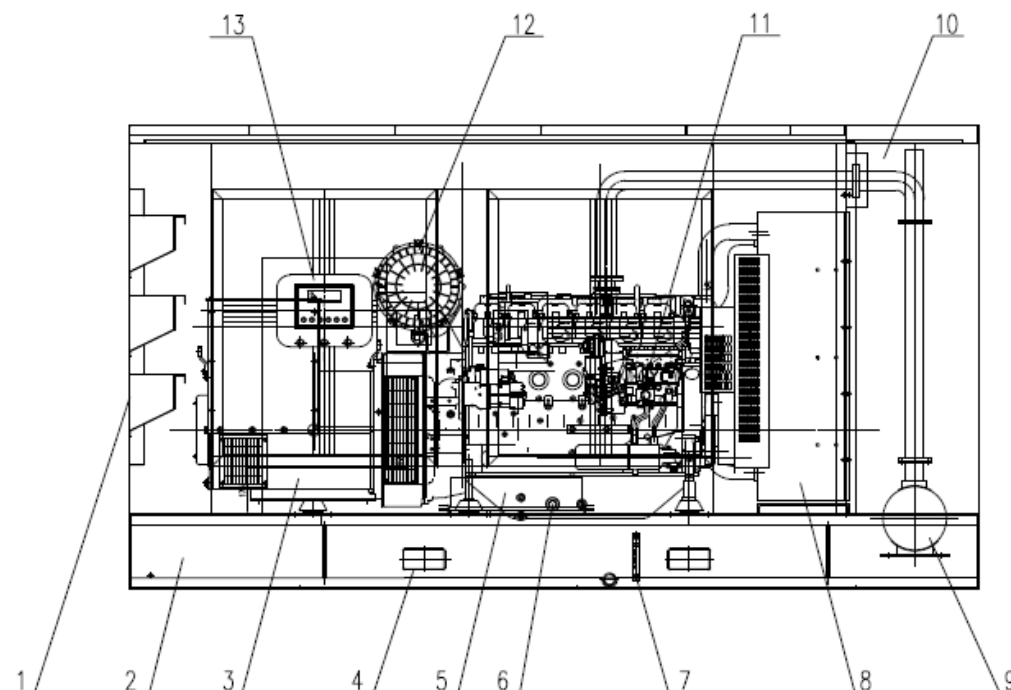
Although output power of diesel Gen-set would not decrease when being operated under low temperature and high humidity regions, the factors that may have an impact on normal operation of the Gen-set under different site conditions must be taken into consideration also during model selection.

When the Gen-set is going to be used under non-standard environmental conditions, users shall correct power of the Gen-set according to change of environmental conditions. For details of correction factor, please consult Weichai Power Generation Equipment Co., Ltd.

V. Range of application

At present, diesel Gen-set has been widely used in aviation, shipping, national defense, communication, petroleum, medical treatment, mining, wild rescue, agriculture and animal husbandry, as well as other fields to ensure reliability and stability of power supply system.

Chapter 3 Overview on Main Structure of the Gen-set



1. Air inlet 2. Chassis 3. Alternator 4. Forklift groove 5. Batteries 6. Oil drain hole 7. Fuel level indicator 8. Radiator 9. Silencer 10. Exhaust chamber 11. Inlet of fuel delivery pump 12. Air filter 13. Control panel

Fig. 3-1 Structural schematic diagram of the Gen-set

The Gen-set mainly consists of diesel engine, alternator, control panel, low-noise shed body and chassis, etc. Detail structure of the Gen-set is as shown in Figure 3-1. Main parts of the Gen-set will be detailed below.

I. Diesel engine

Diesel engine is power source of the Gen-set. For detail structure and principles, please refer to Diesel Engine Operation and Maintenance Manual.

II. Alternator

Alternator is a device converting mechanical energy into electrical energy.

1. Structure of alternator

The Weichai Gen-set adopts a brushless three-phase synchronous alternator. As shown in Figure 3-2, the alternator mainly consists of main stator (armature), main rotor (magnetic field), exciter stator (magnetic field), exciter rotor (armature), rotary rectifier, automatic voltage regulator (AVR) and outlet box, etc.

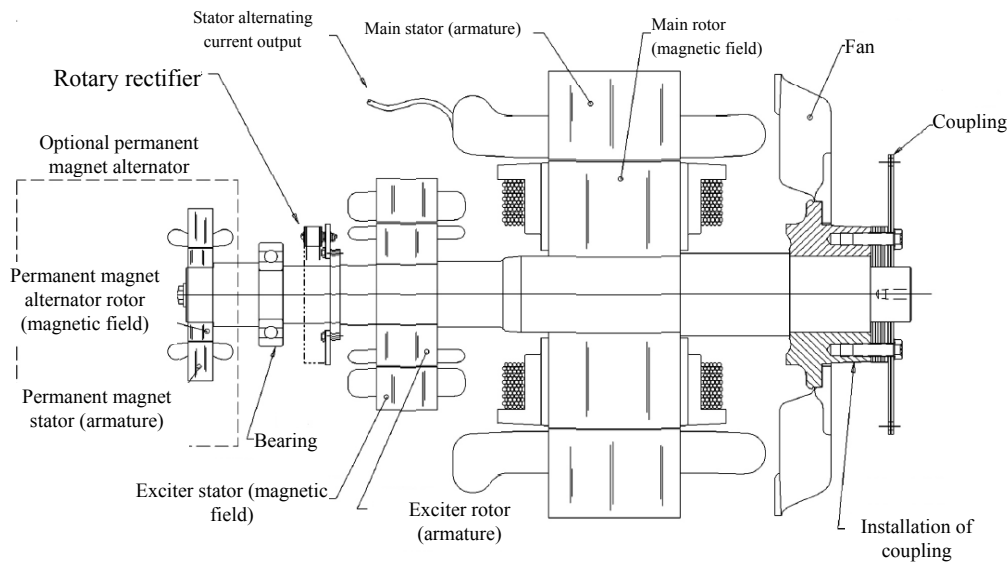


Figure 3-2 Sectional view of alternator

2. Operating principles of alternator

After alternator is driven, main stator (armature) generates certain remanence voltage, automatic voltage regulator (AVR) outputs a remanence current to exciter stator (magnetic field) after obtaining remanence voltage from main stator (armature), exciter rotor (armature) generates three-phase alternating current which is then transmitted to main rotor (magnetic field) excitation winding after being rectified into direct current by rotary rectifier, in order to enhance magnetic field of main rotor and increase voltage of main stator (armature). By constant cycling of this voltage buildup process, alternator builds up rated voltage steadily in a short time.

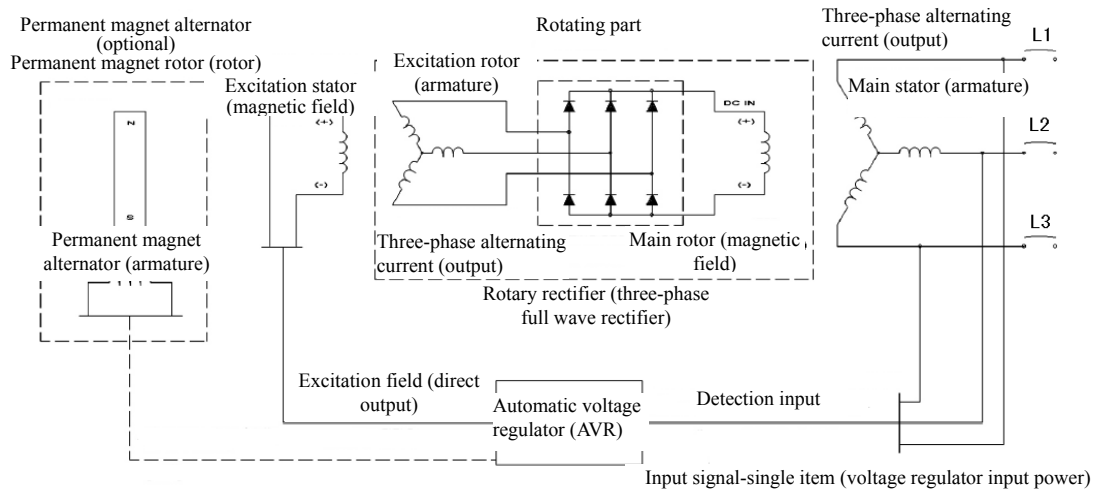


Figure 3-3 Alternator operating principles schematic diagram

3. Automatic voltage regulator (AVR)

AVR of Weichai alternator is a half-wave phased thyatron type automatic voltage regulator and one part of alternating-current brushless alternator excitation system. Except regulating voltage of alternator, AVR is equipped with low-speed and no-detection signal protection function, in order to ensure that alternator is controlled in a safe and reliable way.

Weichai 20-120kW Gen-set is equipped with AS440, BE350, AS480 or KRS440 type AVR (type of AVR is clearly marked on nameplate of alternator). Structure and function of AVR are described below respectively.

3.1 AS440

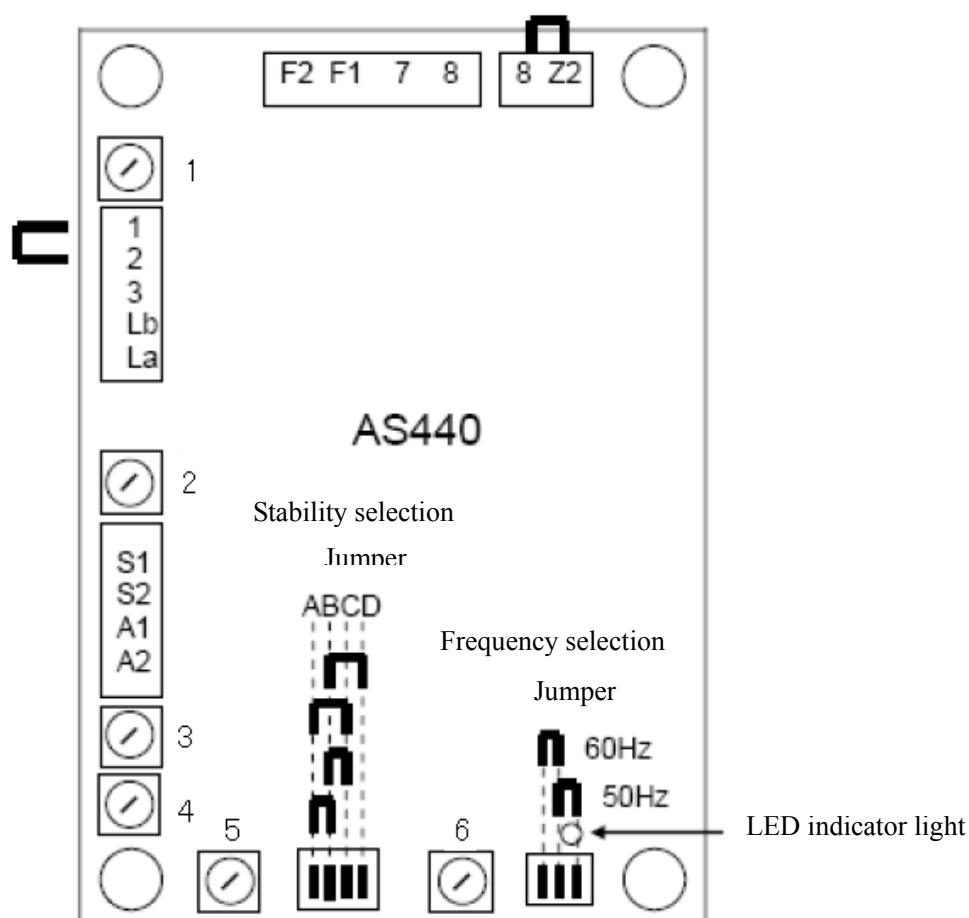


Figure 3-4 AS440 Structure diagram

1) Generally, terminal 8 and Z2 are short-connected. However, if the alternator is equipped with auxiliary winding, they shall be disconnected and connected to auxiliary winding;

2) As shown in Figure 3-5, terminal 7 and 8 are connected to main stator (armature) of alternator and terminal F1 and F2 are connected to exciter stator (magnetic field);

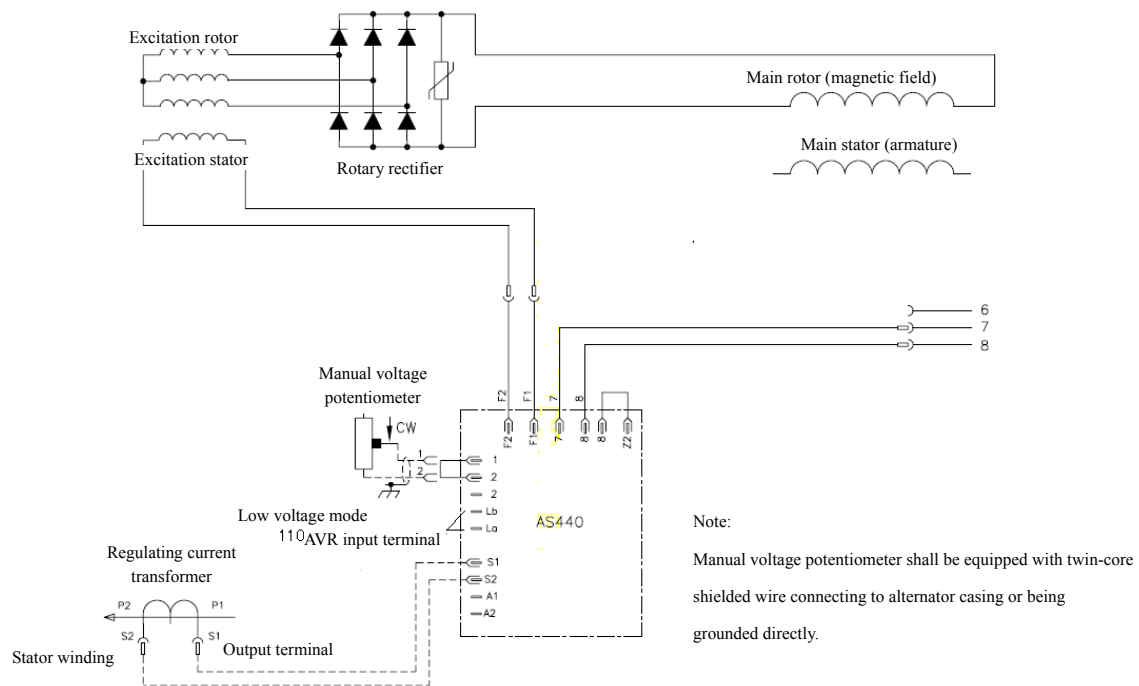


Figure 3-5 AS440 Wiring diagram

3) Terminal 1 and 2 are used for external connection of voltage regulator, thus they must be short-connected if external voltage regulator is not installed;

4) Terminal La and Lb are only applicable for some special low-voltage applications;

5) When this Gen-set is connected in parallel, S1 and S2 are used for connection of regulating current transformer and A1 and A2 are used for connection of VAr/PF controller;

6) Stability adjustment shall be selected as per Table 3-1;

Table 3-1 Stability selection list

Serial number	Power range	Response speed
B-D	<100kW	Slow
A-C	<100kW	Fast
B-C	100-550kW	Fast
A-B	> 550kW	Fast

7) Frequency selection is as shown in Figure 3-4.

8) See Table 3-2 for roles and adjustment methods of AVR adjustment potentiometer.

Table 3-2 Function list of AS440 adjustment potentiometer

No. in figure	Control button	Function	Direction of adjustment
1	Voltage	Adjust output voltage of alternator	Turn clockwise to increase output voltage
2	Droop (applicable for parallel connection)	Droop is 5% when power factor of Gen-set is 0	Turn clockwise to increase droop
3	Fine adjustment	Increase analog input sensitivity	Turn clockwise to increase gain or sensitivity
4	Over-excitation tripping	Set over-excitation tripping trigger potential	Turn clockwise to increase tripping trigger potential
5	Stability	Prevent voltage swing	Turn clockwise to increase damping effect
6	UFRO (Under-Frequency Roll Off)	Set UFRO knee point	Turn clockwise to decrease knee point frequency

3.2 BE350

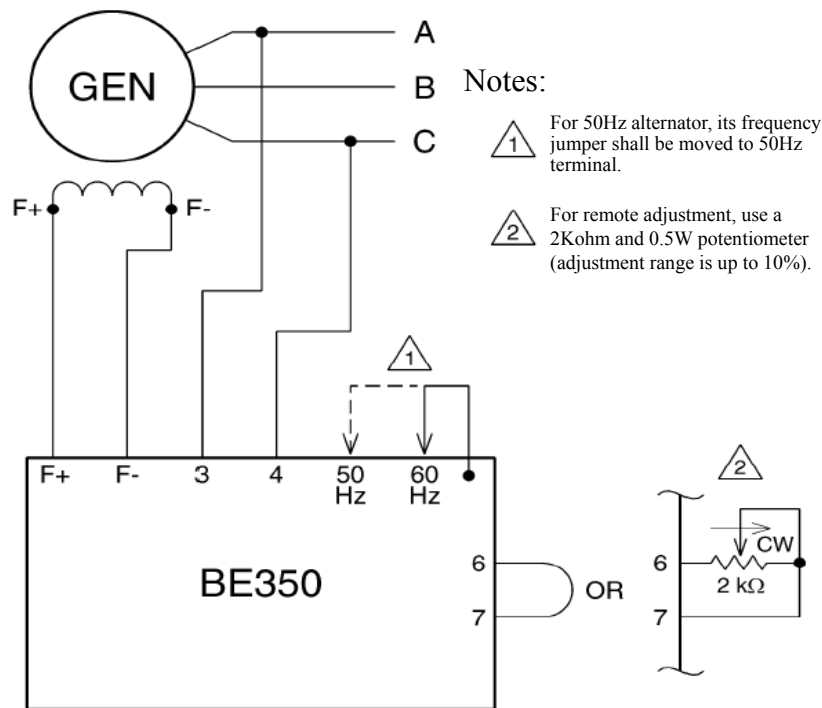


Figure 3-8 BE350 wiring diagram

1) F+ and F- terminal of the regulator shall be connected to positive and negative electrode of brushless exciter's excitation winding respectively. If DC resistance of excitation winding is less than 21Ω and exciting current under full load is not greater than maximum continuous rated current of regulator, excitation winding must be connected with a enough large resistor in parallel until the resistance reaches to 21Ω ;

2) Excitation winding and regulator of exciter obtain power from output end of alternator. The acceptable power input range is 171~264Vac and power input is connected to terminal 3 and 4.

3.3 AS480

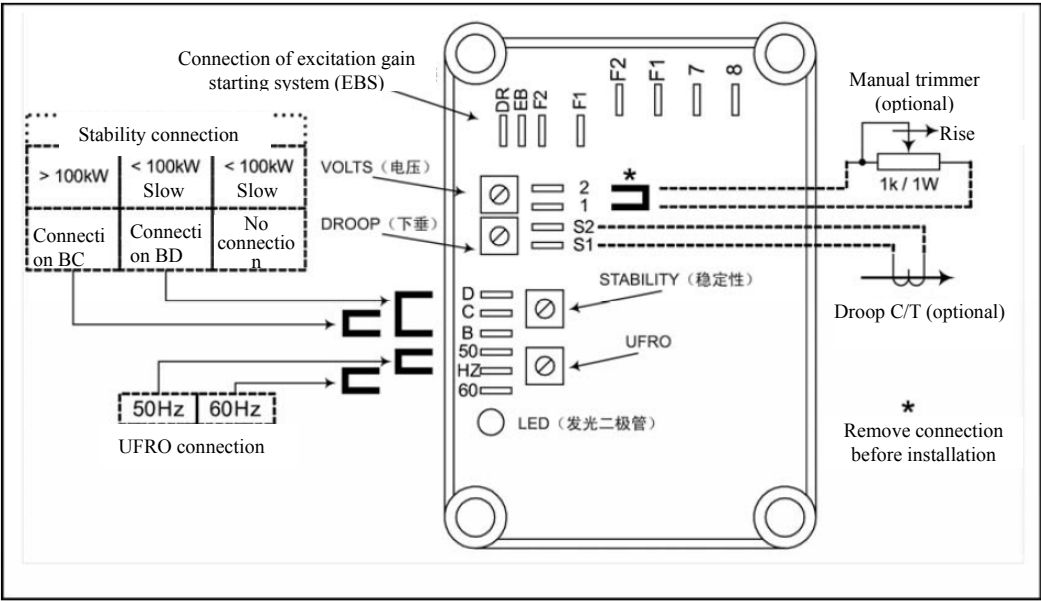


Figure 3-7 AS480 structure and wiring diagram

- 1) Terminal 7 and 8 are connected to main stator (armature) of alternator and terminal F1 and F2 are connected to stator (magnetic field) of exciter.
- 2) Terminal 1 and 2 are used for external connection of voltage regulator, thus they must be short-connected if external voltage regulator is not installed;
- 3) When this Gen-set is connected in parallel, S1 and S2 are used for connection of regulating current transformer;
- 4) Stability adjustment shall be selected as per Table 3-3.

Table 3-3 Stability selection list

Serial number	Power range	Response speed
B-D	<100kW	Slow
No connection	<100kW	Fast
B-C	> 100kW	Fast

- 5) See Table 3-4 for roles and adjustment methods of AVR adjustment potentiometer.

Table 3-4 Function list of AS480 adjustment potentiometer

Control button	Function	Direction of adjustment
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Voltage	Adjust output voltage of alternator	Turn clockwise to increase output voltage
Droop (applicable for parallel connection)	Droop is 5% when power factor of Gen-set is Gen-set as 0	Turn clockwise to increase droop
Stability	Prevent voltage swing	Turn clockwise to increase damping effect
UFRO (Under-Frequency Roll Off)	Set UFRO knee point	Turn clockwise to decrease knee point frequency

3.4 KRS440

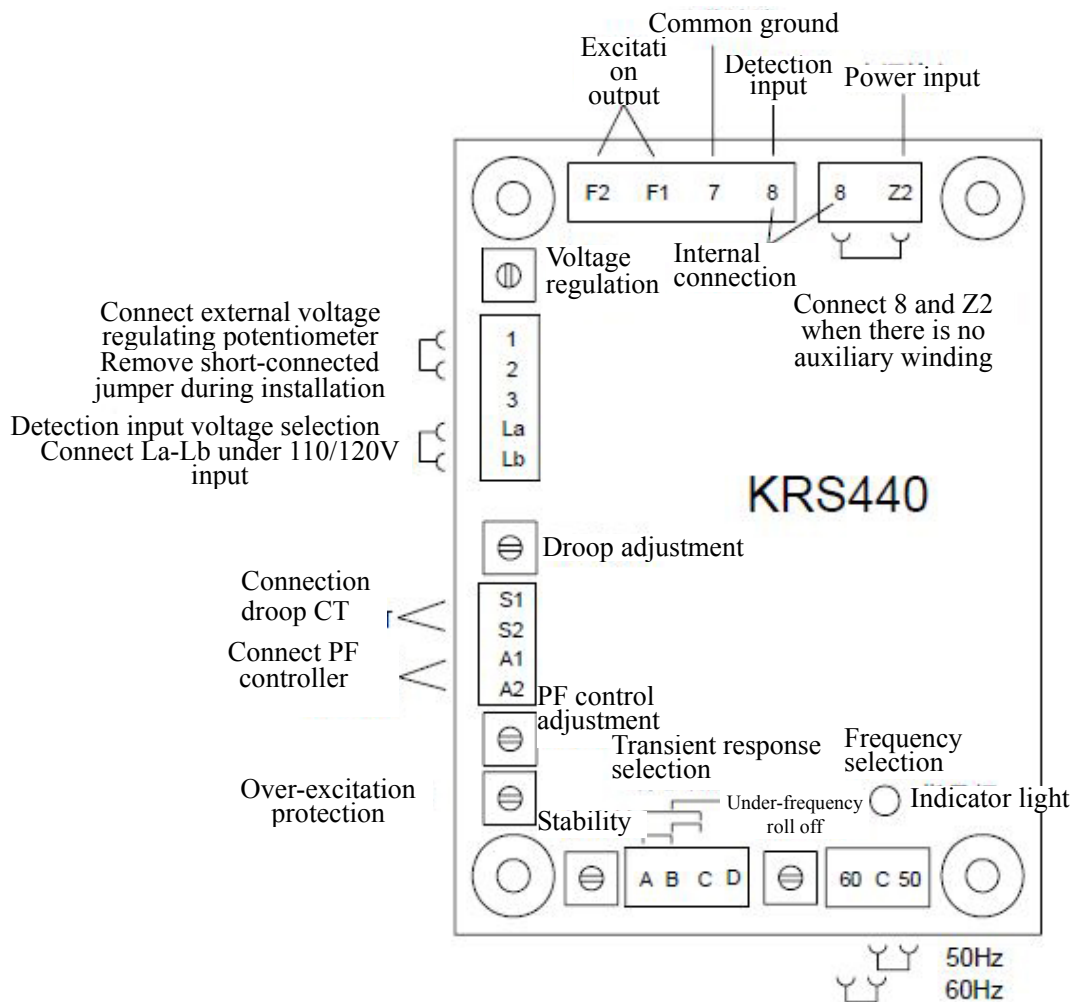


Figure 3-8 KRS440 Wiring diagram

1) Stability adjustment shall be selected as per Table 3-5.

Table 3-5 Stability selection list

Serial number	Power range	Response speed
B-D	<100kW	Slow
A-C	<100kW	Fast
B-C	100kW~500kW	Fast
A-B	>500kW	Fast

2) See Table 3-6 for roles and adjustment methods of AVR adjustment potentiometer.

Table 3-6 Function list of KRS440 adjustment potentiometer

Control button	Function	Direction of adjustment
Voltage adjustment	Adjust output voltage of alternator	Turn clockwise to increase output voltage
Under-Frequency Roll Off	Prevent voltage swing	Turn clockwise to increase stability
Droop (applicable for parallel connection)	Droop is Gen-set to 5% when OPF is fully loaded	Turn clockwise to increase droop
Stability	Prevent voltage swing	Turn clockwise to increase damping effect
PF control adjustment	Optimize sensitivity of analog input	Turn clockwise to increase control on AVR by accessories

3.5 Regulating method of AVR

Adjustment potentiometer on AVR has been set when being delivered from factory, so it is unnecessary to adjust other buttons at random except voltage and stability button.

1) Adjustment method of voltage

Counterclockwise turn voltage adjustment button on AVR to the end, then place this regulator knob to middle position if the alternator is provided with an external voltage regulator. Start Gen-set and slowly turn voltage regulator on AVR clockwise under Rated speed until rated voltage is reached.

2) Adjustment method of voltage stability

When adjustment is necessary for the reason of unstable voltage, following operation procedures shall be followed:

Let the Gen-set to operate without load and check if its speed is correct or not;

Turn stability knob to the end clockwise and then turn it counterclockwise slowly until voltage of alternator starts to fluctuate.

Note: correct setting will be completed just by slightly turning clockwise from this position (namely, at this point, voltage of alternator is stable, but it is also very close to unstable zone).

III. Control panel

Control panel is “brain” of the Gen-set as it not only enables starting, stopping, data measurement, data display and fault protection of engine, but also enables electricity measurement, electricity display and electricity protection, etc. of alternator. The control panel of DSE6020 module or DSE7320 module can be provided with mechanically governing or electronically governing diesel engine. Structure of the control panel of DSE6020 module is as shown in Figure 3-8.

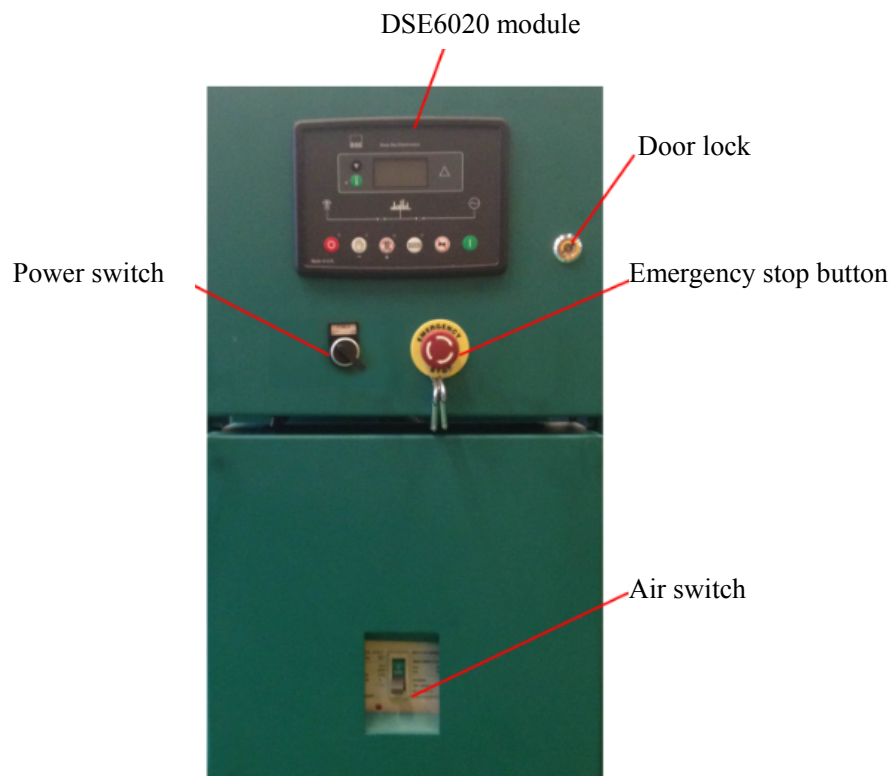


Figure 3-8 Control panel diagram

1. DSE6020 display module

6020 module of Deep Sea Electronics is an AMF/ATS module which is able to display various parameters of engine (speed, oil pressure, water temperature, fuel level and battery voltage), parameters of alternator (frequency, three-phase voltage (L-L and L-N) and current), power parameters of alternator (kVA, kW, PF, kVAR, kWh, kVAH and kVARH), parameters of mains power (frequency, three-phase voltage (L-L and L-N)), contains 7 inputs and 6 outputs (4 outputs can be customized in MPU version and 6 outputs can be customized in CAN version) and sets programs by panel or software. Display content and input/output port of DSE7320 display module of the Gen-set with different configuration may be different slightly.

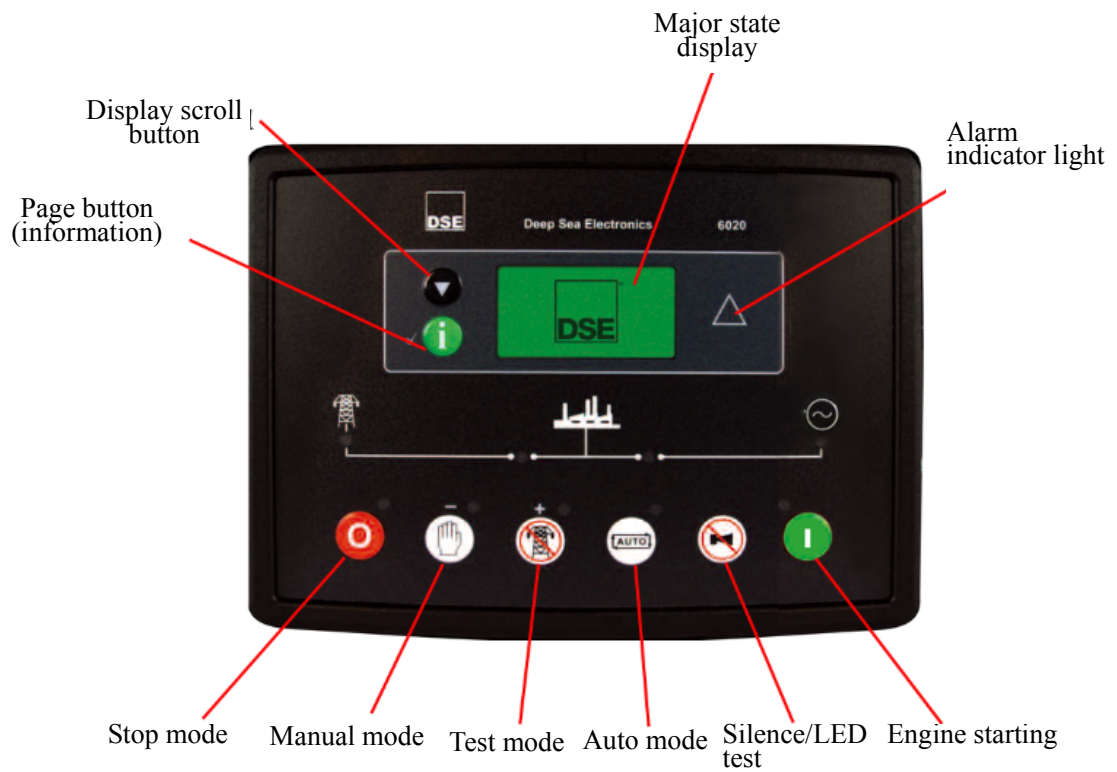


Figure 3-9 DSE6020 module

No.	Function	
1		Display various parameters of Gen-set
2		Page down
3		Press this button to display detail information of current page
4		Stop operation of Gen-set

5		Press this button to enter into manual mode and adjust parameters (-)
6		Simulate state of loss of mains power and adjust parameters (+)
7		Press this button to enter into AUTO mode
8		Silence button
9		Start Gen-set
10		Alarm indication light, the module will record the latest 5 alarm records for ease of maintenance

2. Power switch

Control power on/off of control panel of the Gen-set.

3. Emergency stop button

Press this button to stop the Gen-set immediately when any emergency occurs. And, the Gen-set is unable to be started under this state. When the emergency situation is over, the Gen-set can be started only after emergency stop button is released.

4. Air switch

Except closing and opening of circuit, it is still available for short-circuit and

serious overload protection of circuits or electrical equipment.

Structure of the control panel of DSE7320 module is as shown in Figure 3-10.



Figure 3-10 Control panel drawing

1. DSE7320 display module

7320 module of Deep Sea Electronics is an AMF/ATS module which is able to display various parameters of engine (speed, oil pressure, water temperature, fuel level and battery voltage), parameters of alternator (frequency, three-phase voltage (L-L and L-N) and current), power parameters of alternator (kVA, kW, PF, kVAR, kWh, kVAH and kVARH), parameters of mains power (frequency, three-phase voltage (L-L and L-N)), contains 12 inputs and 8 outputs (8 inputs and 4 outputs can be customized) and sets programs by panel or software. Display content and input/output port of DSE7320 display module of the Gen-set with different configuration may be different slightly.

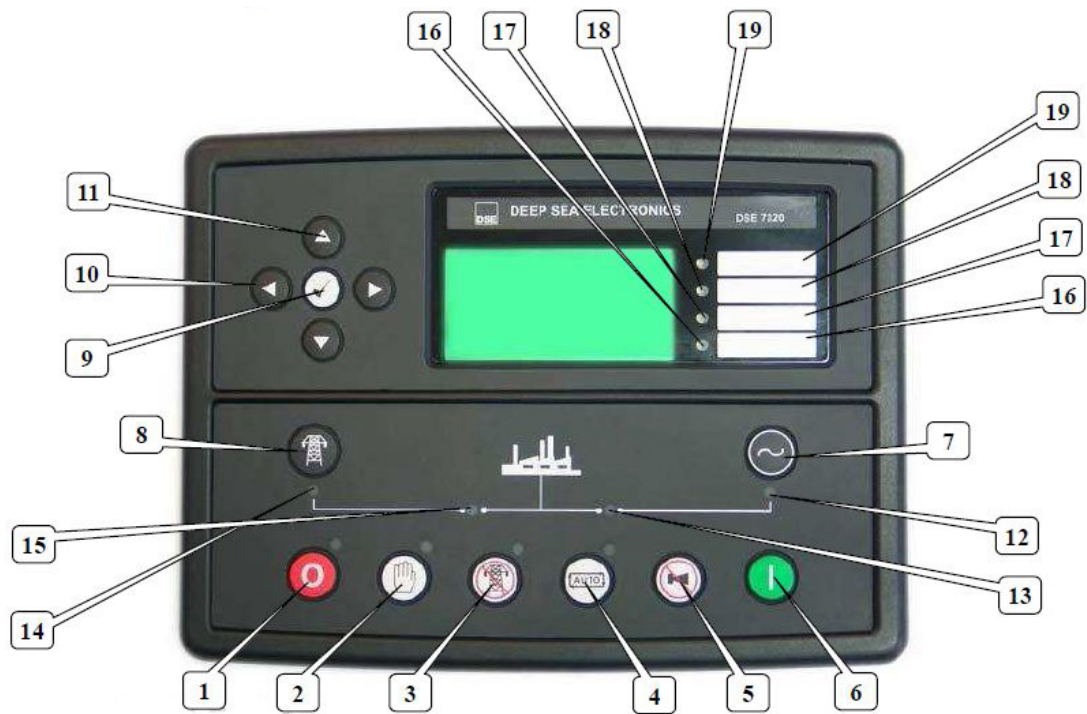


Figure 3-9 DSE6020 module

No.	Function	
1		Gen-set stop and fault resetting button
2		Gen-set manual mode button
3		Mains power fault simulation and test button
4		Gen-set AUTO mode button

5		Silence button
6		Gen-set start button (operative under manual mode)
7		Alternator switching-on button
8		Mains power switching-on button (applicable for the case when AMF function is used)
9		Enter button
10		Left and right menu navigation button, used to select menu in turn
11		Up and down selection button, used to query parameters in each menu in turn

LED indicator light:

12. When generated electricity (Gen-set operates normally) exists, green light turns on

13. When generated electricity (the Gen-set supplies power to loads) is switched on, green light turns on

14. When mains power (usage of AMF function is available) exists, green light turns on

15. When mains power (mains power system supplies power to loads, which is applicable when AMF function is used) is switched on, green light turns on

16. When common alarm is generated, green light turns on

17. When low oil pressure alarm is generated, green light turns on

18. When high water temperature alarm is generated, green light turns on

19. When AUTO mode is enabled, green light turns on

Note: 4 LED indicator lights are customized according to actual needs in 16-19 and these 4 LED indicator lights customized here are taken as an example only.

2. Power switch

Control power on/off of control panel.

3. Emergency stop button

Press this button to stop the Gen-set immediately when any emergency occurs. And, the Gen-set is unable to be started under this state. When the emergency situation is over, the Gen-set can be started only after emergency stop button is released.

4. Air switch

Except closing and opening of circuit, it is still available for short-circuit and serious overload protection of circuits or electrical equipment.

3. Electrical schematic diagram

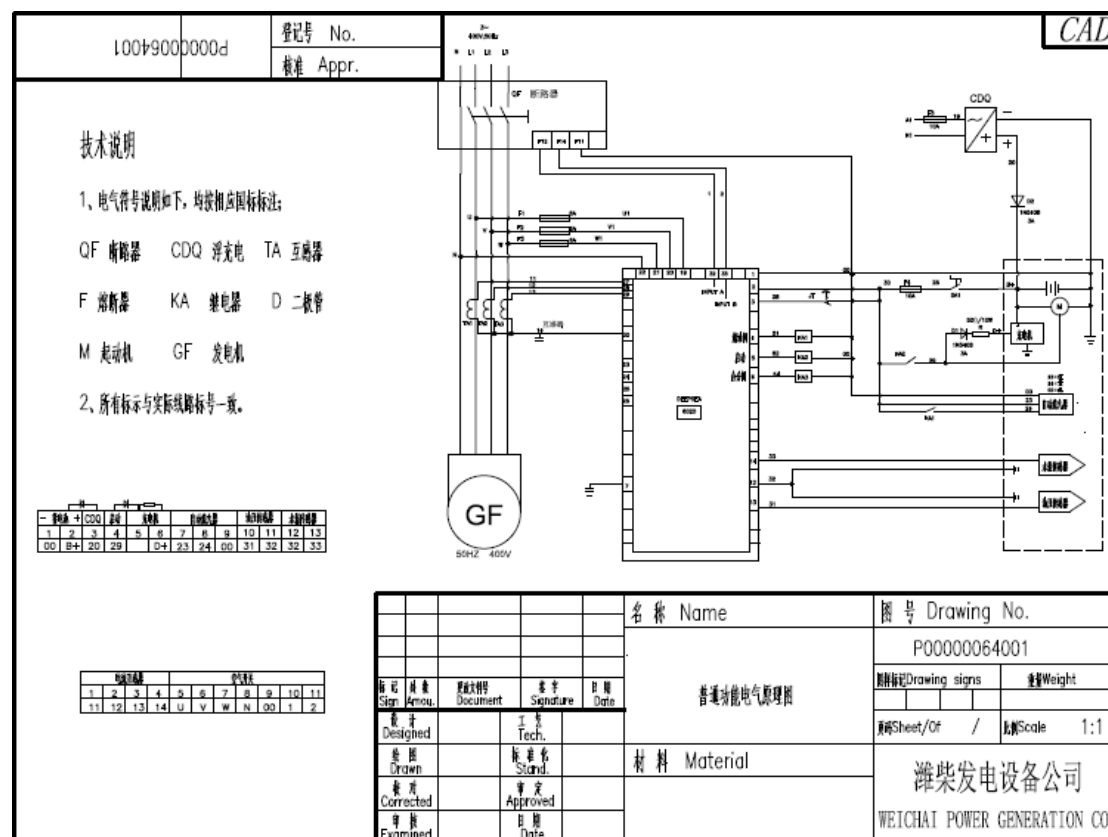


Figure 3-10 Electrical Schematic Diagram of DSE6020 Module's Mechanical Governing Common Functional Gen-set

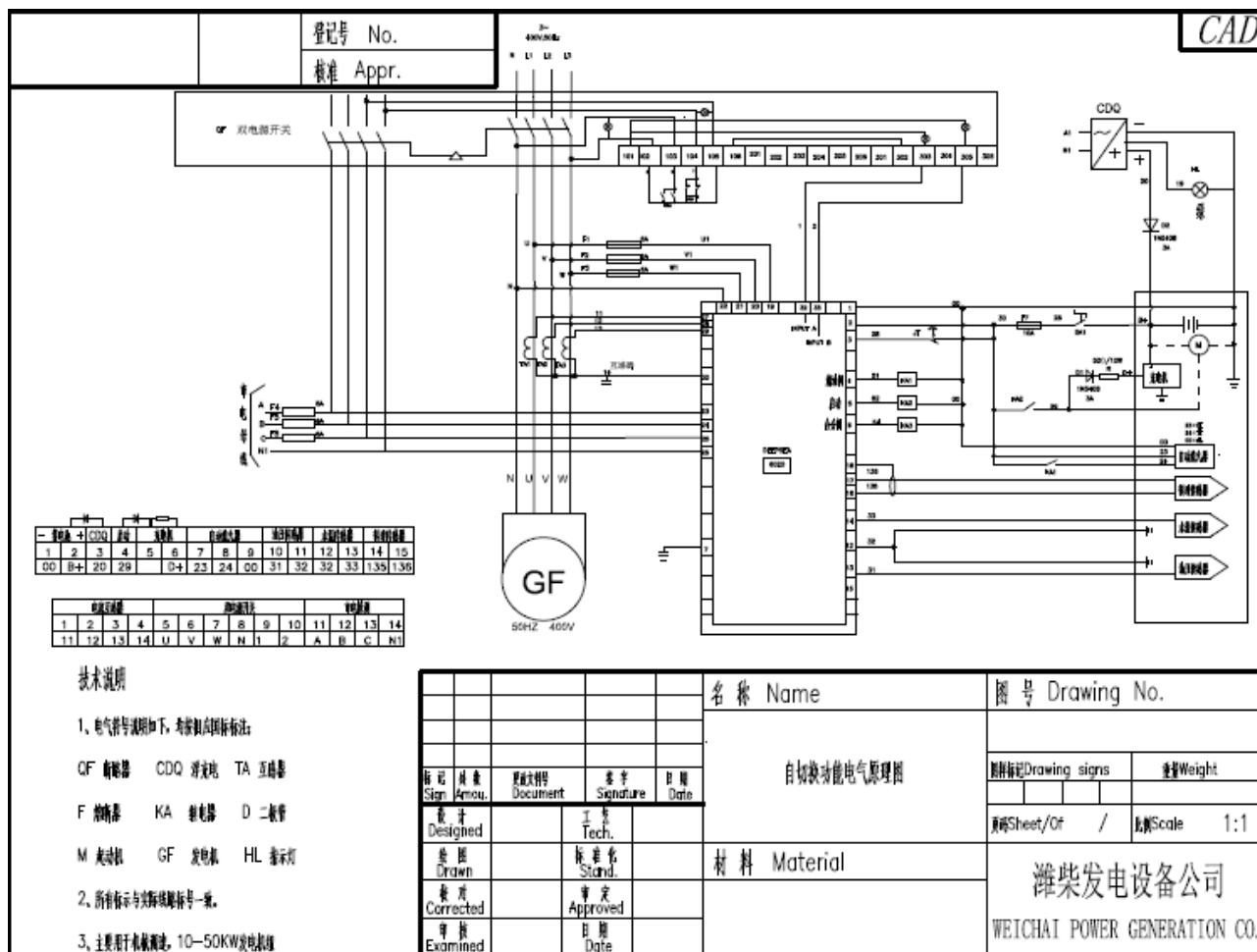


Figure 3-11 Electrical Schematic Diagram of DSE6020 Module's Automatic Change-Over Mechanical Governing Gen-set

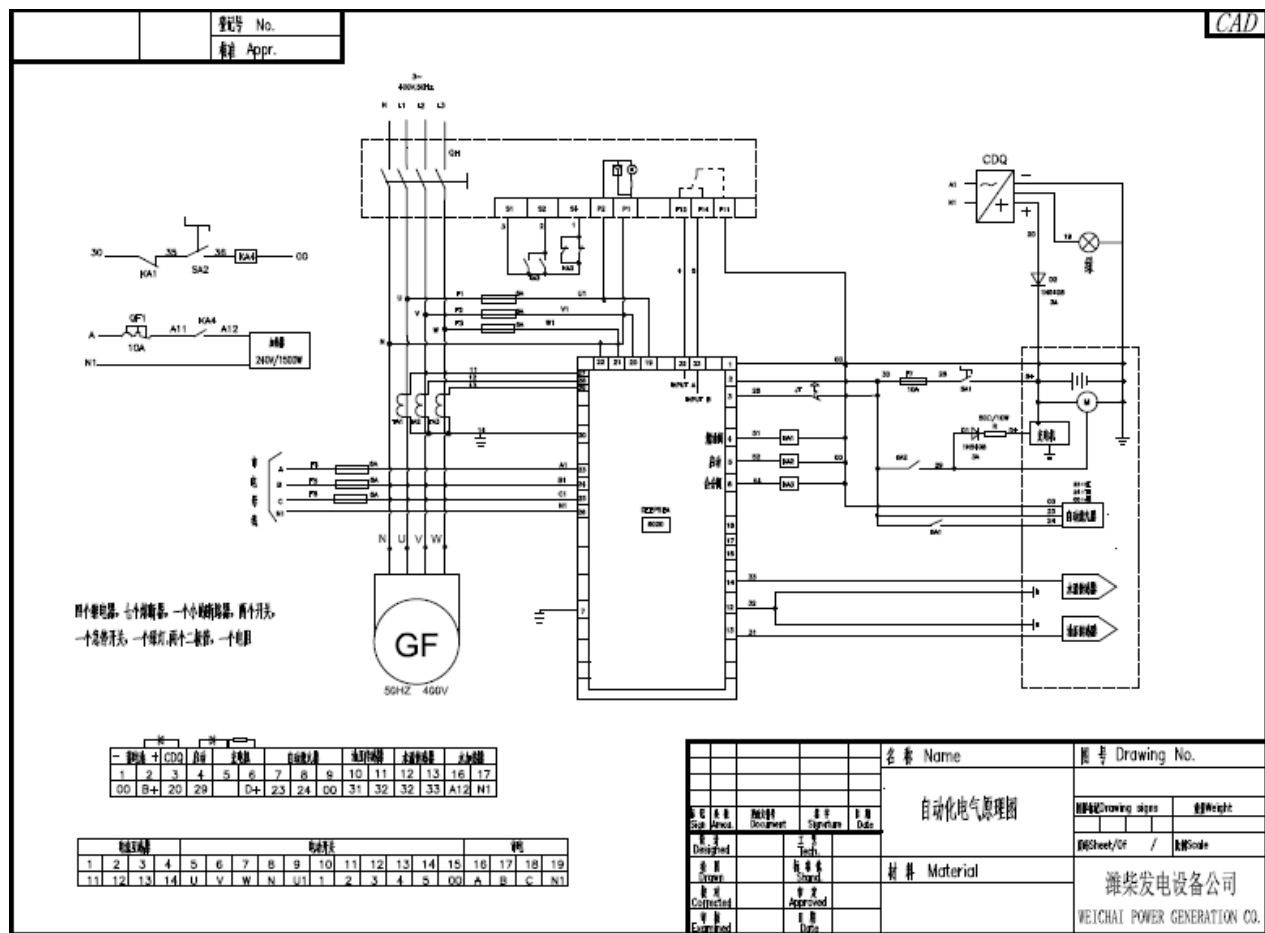
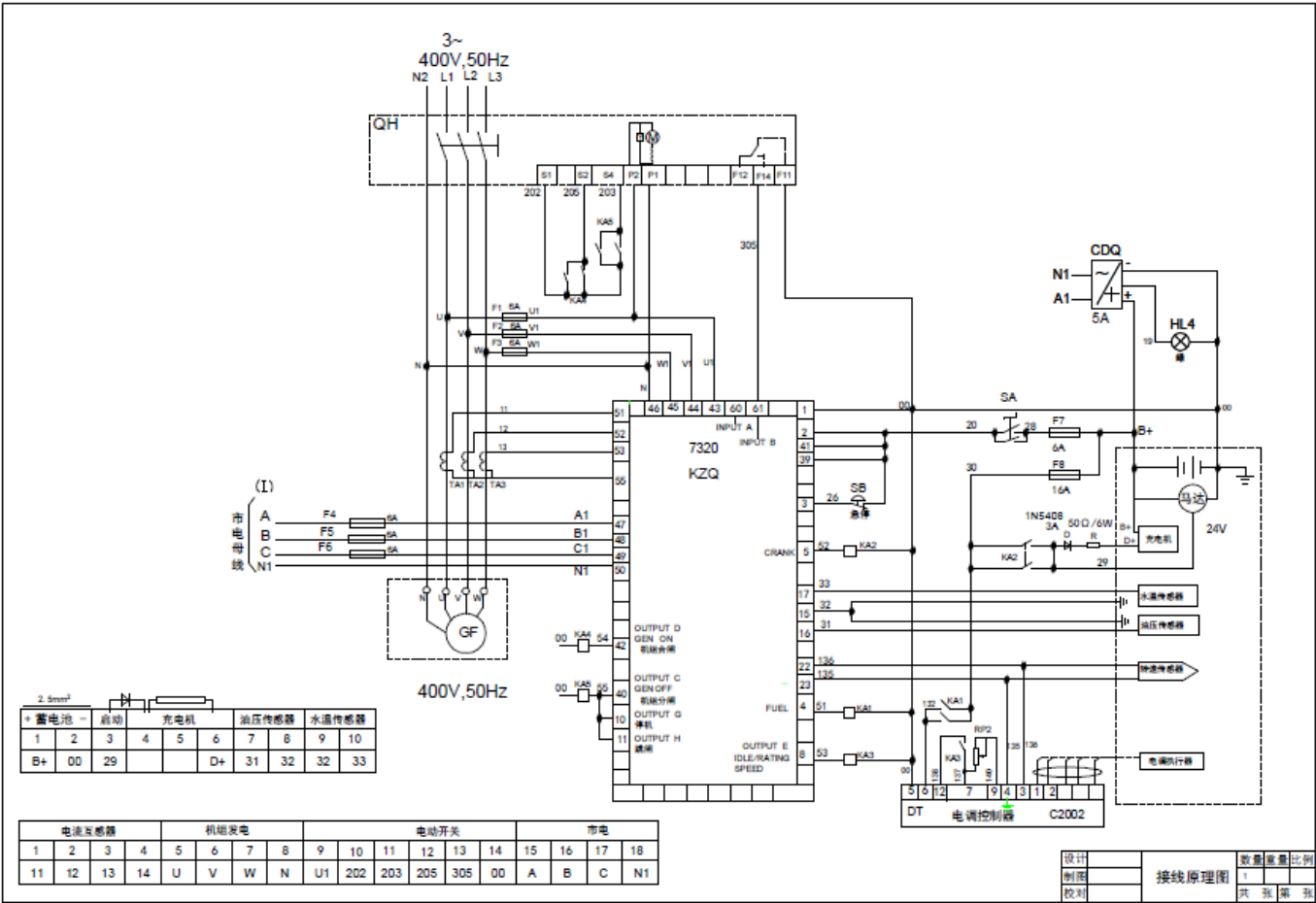


Figure 3-12 Electrical Schematic Diagram of DSE6020 Module's Automatic Mechanical Governing Gen-set



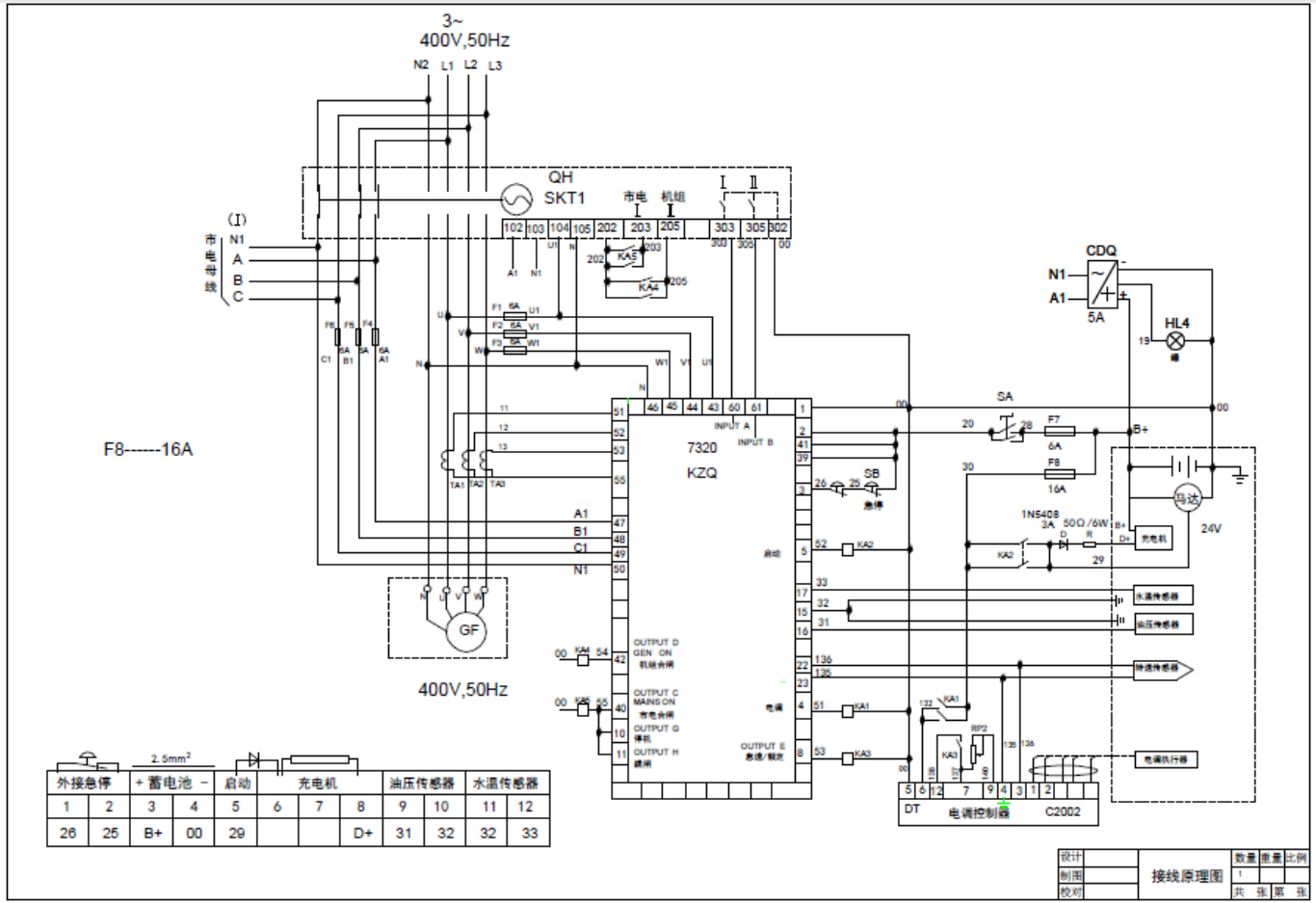


Figure 3-14 Electrical Schematic Diagram of DSE7320 Module's Automatic Change-Over Electronic Governing Gen-set

Chapter 4 Main Specifications and Technical Parameters of the Gen-set

Model	WPG27.5L9	WPG33L9	WPG41L9	WPG55L9	WPG68.5L9
Rated power (kW)	20	24	30	40	50
Rated voltage (V)	400	400	400	400	400
Rated frequency (Hz)	50	50	50	50	50
Rated current (A)	36	43	54	72	91
Rated speed (r/min)	1500	1500	1500	1500	1500
Rated power factor (lagging)	0.8	0.8	0.8	0.8	0.8
Coolant volume (L)	11	11	11	11	11
Lubricating oil volume (L)	7.25	7.25	7.25	10	10
Maximum allowable exhaust back pressure (kPa)	6.5	6.5	6.5	6.5	6.5
Rated load fuel consumption (L/h)	5	6	7.5	10	12.5
Oil/fuel consumption ratio	$\leq 0.4\%$	$\leq 0.4\%$	$\leq 0.4\%$	$\leq 0.4\%$	$\leq 0.4\%$
Alternator insulation grade	H	H	H	H	H
Alternator protection grade	IP21	IP21	IP21	IP21	IP21
Overall dimensions (mm)	2300×960×1490	2300×960×1490	2300×960×1490	2600×1050×1630	2600×1050×1630
Net weight of the Gen-set (kg)	1080	1110	1140	1415	1445
Battery voltage (V) -	12	12	12	24	24

Battery capacity (A·h)-Shuangdeng	40	40	40	40*2	40*2
Cooling area (mm)	0.143	0.143	0.143	0.205	0.205

Model	WPG88L9	WPG103L9	WPG123.5L9	WPG137.5L9	WPG165L9
Rated power (kW)	64	75	90	100	120
Rated voltage (V)	400	400	400	400	400
Rated frequency (Hz)	50	50	50	50	50
Rated current (A)	115	135	162	180	217
Rated speed (r/min)	1500	1500	1500	1500	1500
Rated power factor (lagging)	0.8	0.8	0.8	0.8	0.8
Coolant volume (L)	12	12	16	16	16
Lubricating oil volume (L)	10	10	18	18	18
Maximum allowable exhaust back pressure (kPa)	6.5	6.5	6.5	6.5	6.5
Rated load fuel consumption (L/h)	16	18.75	22.5	25	30
Oil/fuel consumption ratio	$\leq 0.4\%$	$\leq 0.4\%$	$\leq 0.4\%$	$\leq 0.4\%$	$\leq 0.4\%$
Alternator insulation grade	H	H	H	H	H
Alternator protection grade	IP21	IP21	IP21	IP21	IP21
Overall dimensions (mm)	2800×1050×1630	2800×1050×1630	3200×1100×1750	3200×1100×1750	3200×1100×1750
Net weight of the Gen-set (kg)	1580	1620	2040	2040	2065

Battery voltage (V) -	24	24	24	24	24
Battery capacity (A·h)-Shuangdeng	40*2	40*2	40*2	40*2	40*2
Cooling area (mm)	0.32	0.32	0.40	0.40	0.40

Note: 1. Above main specifications and technical parameters of the Gen-set are for reference only. We reserve the right to optimize and change design the Gen-set and change parameters without further notice.

2. The Gen-set of other voltage and frequency, etc. can be customized according to requirements of customers.

Chapter 5 Transportation of the Gen-set

The diesel Gen-set shall be provided with necessary safety protections during transportation.

The wooden carrying case, standard configuration of Weichai Gen-set, can prevent the Gen-set from being suffered from damages caused by external shocks effectively.

In addition, the Gen-set shall be firmly secured during transportation, in order to prevent loosening or damage of parts caused by vibration.

When loading or unloading the Gen-set onto or from the vehicle, use a crane to lift up the Gen-set in a balanced way, in order to avoid damage of the Gen-set caused by tilting or falling to the ground.

Chapter 6 Installation of the Gen-set

I. Preparations before installation

1. Unpacking of the Gen-set

Before unpacking, clean dust and check if body of the case is damaged or not at first. Then, check case number and quantity and do not damage the machine during unpacking. During unpacking, top plate shall be removed first and side plates shall be removed latter. Followings are necessary after unpacking:

- 1) Checking of Gen-set nameplate and checking if the Gen-set meets ordering requirements or not;
- 2) Making an inventory on the Gen-set and its accessories in accordance with packing list of the Gen-set;
- 3) Checking if the Gen-set and its accessories are damaged or rusted or not;

The Gen-set after being unpacked must be positioned horizontally and flanges and various joints must be sealed, in order to prevent intrusion of moisture and foreign objects.

2. Preparations for equipment installation

Before installation of the Gen-set, relevant equipment and tools (e.g. crane, forklift and wrench, etc.) shall be prepared as per construction scheme.

II. Requirements for installation of the Gen-set

1. Size of equipment room

1) Size of equipment room of the Gen-set shall meet space requirements for installation, operation and maintenance of the Gen-set.

2) An opening for transporting of the Gen-set shall be reserved in the equipment room, in order to ensure that the Gen-set can be moved to its installation position. At least a 3500×2500mm opening for transportation shall be reserved for 20~120kW

series Gen-set;

3) The equipment room shall provide enough space for maintenance of the Gen-set and distance from edges of installed Gen-set to wall surface shall not be less than 1,500mm;

4) There are shall be enough space for arrangement of exhaust pipe at height direction of equipment room and height of equipment room for 20~120kW series Gen-set shall not be less than 4,000mm.

Suggestion: dimensions of the equipment room built for 20~30kW Gen-set, 40~75kW Gen-set and 90~120kW Gen-set shall be 4320mm (L)×3500mm (W)×4000mm (H), 4700mm (L)×3500mm (W)×4000mm (H), and 5150mm (L)×3500mm (W)×4000mm (H) respectively.

2. Requirements for foundation

Foundation of the Gen-set must meet following requirements:

1) Able to support total wet weight of Gen-set, including the Gen-set, accessory equipment, coolant, lubricating oil and diesel oil, etc.;

2) Able to withstand periodic vibration during operation of the Gen-set.

It is recommended that customers cast a concrete foundation as per following design principles:

1) Overall dimensions of the foundation must at least 300mm larger than that of Gen-set;

2) Height of foundation shall be calculated as per following formula:

$$FD = \frac{2W}{D \times B \times L}$$

Wherein:

FD=foundation height, m;

W=total wet weight of the Gen-set, kg;

D=density of concrete, kg/m³ (2,402.8 kg/m³)

L=length of foundation, m;

F=width of foundation, m.

Suggestion: dimensions of foundation for 20~30kW Gen-set, 40~75kW Gen-set and 90~120kW Gen-set are 2820mm (L)×1500mm (W)×200mm (H), 3200mm (L)×1500mm (W)×200mm (H), and 3650mm (L)×1500mm (W)×200mm (H) respectively.

3. Transportation of the Gen-set

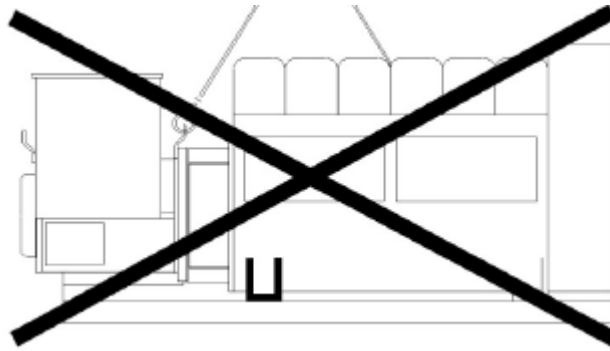
Common chassis of Weichai Gen-set is designed with lifting eye and forklift groove and the Gen-set can be transported and installed by using crane or forklift.

When crane is used, in order to prevent the Gen-set from being titled when being lifted up, four steel wire ropes whose length is the same shall be used. In addition, these steel wire ropes shall have enough strength and carrying capacity of lifting tools shall meet requirements of safety specifications. When being lifted, the Gen-set shall be kept horizontal and lifted slowly, in order to prevent the Gen-set from swinging and prevent steel wire ropes from tied during lifting.

When using forklift, be sure to hold up the Gen-set slowly or carefully push or pull from base of the Gen-set.

Note: parts of the Gen-set would be seriously damaged if incorrect transportation method is adopted.

Note: do not lift up the Gen-set from lifting eyes on diesel engine or alternator.



Note: check if suspension equipment and supports are in good conditions and if load weight of suspension equipment is proper.

Note: for outdoor lifting, do not lift up the Gen-set in heavy windy days.

Warning: all people shall be kept away from lifted Gen-set.

4. Installation of the Gen-set

The Gen-set shall be connected to foundation with anchor bolts or proper cushions.

Fixing chassis of the Gen-set to foundation with anchor bolts can not only reduce vibration effectively, but also can prevent moving of the Gen-set. Therefore, damage of the components on the Gen-set caused by vibration can be avoided also.

Alternatively, you can add proper number of anti-vibration pads between chassis of the Gen-set and foundation because these anti-vibration pads can not only make up fine unevenness of ground, but also increase resistance between the Gen-set and ground and improve cushioning function.

Suggestion: fix with anchor bolts because anti-vibration pads would be worn and deformed after long period of service, causing working plane of the Gen-set to become uneven and causing operating condition of the Gen-set to become worse accordingly.

5. Ventilation system

Ventilation of equipment room mainly aims to provide enough cooling air to

bring away heat emitted by Gen-set and provide enough air needed for combustion.

Design principles for ventilation system of equipment room are as follows:

1) Effective intake ventilation area of air intake shutter shall be greater than air flow of radiator fan + air quantity demanded for combustion;

2) Air exhaust shutter shall be connected to radiator of the Gen-set via heat-resisting and grease-proofing wind scooper. Generally, area of the wind scooper shall be 1.5 times of that of radiator core;

3) If efficiency of ventilation is poor, install a ventilating duct and adopt forced ventilation system when necessary.

Suggestion: effective air intake/exhaust area of 20~30kW series Gen-set shall not be less than 0.7m^2 and $800\times 800\text{mm}^2$ respectively; effective air intake/exhaust area of 40~75kW series Gen-set shall not be less than 1.3m^2 and $1170\times 1100\text{mm}^2$ respectively; and effective air intake/exhaust area of 90~120kW series Gen-set shall not be less than 1.8m^2 and $1200\times 1400\text{mm}^2$ respectively.

6. Smoke exhaust system

Smoke exhaust system refers to the exhaust pipe connecting from smoke exhaust port of diesel engine to outside of the equipment room. The exhaust system consists of silencer, bellow, flange, elbow and gaskets associated with the engine, as well as exhaust pipe connecting it to outside of equipment room.

Design of smoke exhaust system of the Gen-set shall meet following requirements:

6.1 Allowable maximum exhaust back pressure of diesel engine shall not exceeded, or performance of diesel engine would be influenced, power of diesel engine would be reduced and fuel consumption, exhaust temperature and emission shall be increased. In order to reduce exhaust back pressure, following measures shall be taken:

1) Number of elbow shall be reduced as much as possible and the number of 90°elbows shall not be more than three;

2) Internal bending radius of 90°elbow shall be no less than 3 times the diameter;

3) Total length of exhaust pipe shall be shortened as much as possible.

6.2 The exhaust system shall be equipped with expansion joint to adapt to unreasonable installation of exhaust pipe or rigid deformation caused by thermal expansion during operation of the Gen-set and absorbing vibration of exhaust system parts.

6.3 Fixation of exhaust pipe: exhaust pipe shall be supported and fixed with the help of buildings or steel structural. If exhaust system is fixed by suspension on ceiling, exhaust pipe shall be at least 2.5m high above the ground in order to ensure safety of personnel travelling across the ground and prevent accidental contact.

6.4 Owing to the fact that temperature of exhaust pipe is high, in order to prevent burns and prevent rising of temperature in equipment room caused by radiant heat, heat insulation treatment shall be carried out. And, heat insulation materials shall be wrapped with glass fiber or aluminum silicate effective for heat insulation and noise reduction. In addition, exhaust terminal and exposed part of exhaust pipe shall be kept away from woods or other flammable substances.

6.5 Exhaust terminal shall be able to avoid dropping of rain water. The exhaust pipe can be projected horizontally and chamfered at end to an angle of 30°~45°. In order to prevent rain water and condensed fluid flows backward to the Gen-set. The exhaust pipe placed horizontally shall be titled to some angle, low end of it shall be kept away from engine, silencer and any section of the pipe where condensed liquid exists (e.g. vertical turn of exhaust pipe) shall be equipped with outlet.

6.6 Position of exhaust outlet shall be designed as per following principles:

- 1) Keep away from air intake;
- 2) Reduce noise impacts on environment;
- 3) Avoid dust generated in exhausting from accumulating on adjacent buildings.

7. Fuel supply system

Daily-use fuel tank and fuel pipelines shall be provided to this series of Gen-set according to specific circumstances to supply fuel to the Gen-set.

7.1 Daily-use fuel tank

1) Fuel capacity of standard configured chassis fuel tank provided for low-noise series Gen-set can meet 8h operation demand of the Gen-set; if the Gen-set is used as a daily power source, you'd better select a daily-use fuel tank with proper capacity meeting 24h continuous operation of the Gen-set under rated load.

Suggestion: it is recommended to select 180L daily-use fuel tank for 20~30kW Gen-set; 300L daily-use fuel tank for 40~50kW Gen-set; 450L daily-use fuel tank for 64~75kW Gen-set; and 720L daily-use fuel tank for 90~120kW Gen-set.

2) The daily-used fuel tank shall be installed at a place which it is convenient for refueling and not far away from the Gen-set. Except refilling oil to daily-use fuel tank manually, it is acceptable to refill fuel to daily-use fuel tank by a manual pump or automatic refueling system;

3) Outlet of daily-used fuel tank shall be at a position which is 0.5m above foundation of the Gen-set (the same with height of fuel injection pump of diesel engine). The outlet shall not be too high (not 1m higher than fuel injection pump), in order to avoid its pressure from exceeding maximum pressure resistance of fuel pump of the Gen-set; and, it shall not be too low (not 0.5m lower than fuel injection pump), in order to prevent it from exceeding suction range of fuel injection pump;

4) The daily-used fuel tank shall be equipped with grounding device to prevent

fire caused by internal electrostatic spark generated during refueling.

7.2 Fuel delivery pipe

1) Diameter of fuel pipe depends on inlet diameter of fuel injection pump and shall be the same with inner diameter of inlet at least; if it is far in distance, diameter of the pipe shall be increased properly; in general, outlet of daily-used fuel tank shall be provided with an auxiliary fuel pump in order to avoid excess siphon pressure from being produced in the pipe.

2) Connection between pipe and the Gen-set shall be flexible and close to fuel pump of the Gen-set as much as possible.

3) Exposed sections of the pipe shall be supported and protected properly, in order to prevent them from being damaged;

4) The pipe shall be kept away from high-temperature parts, such as hot pipes, stove, electric wires, exhaust pipe, etc. If ambient temperature is relatively high, proper heat insulation measures shall be taken.

5) After the pipe is installed, clean it and check if there is any leakage, as well as bleed air in the pipe;

6) The part where fuel return pipe enters into daily-use fuel tank shall be higher than the maximum fuel level.

8. Power cable

8.1 Power cable selection

Connecting cable between breaker of the Gen-set and loads shall be flexible. If flexible cable is unavailable due to installation limitations, a junction box shall be provided near the Gen-set and connected to breaker of the Gen-set with flexible cable.

Power cable of the Gen-set shall be selected as per carrying capacity of cable,

while carrying capacity of cable is relative to both cross section of it and material, type and laying method of cable, as well as ambient temperature. In addition, influence factors are many and calculation is complex also. Weichai recommends you to select cable as per following specifications:

Table 6-1 Specifications of power cable of the Gen-set

No.	Power of the Gen-set (kW)	Specifications of copper-core insulated cable (sectional area mm ²)
1	20-24	10
2	25-35	16
3	36-55	25
4	56-80	35-50
5	81-120	50-70

8.2 Laying of power cable

Shortest routing, minimum turns, laying and maintenance convenience shall be followed during laying cable, in order to prevent cables from being damaged mechanically or chemically, or by earth current and other factors. Selection of cable laying method depends on engineering conditions, environmental characteristics, cable type and quantity, and other factors and shall be carried out by adhering to the principles of reliable operation, ease of maintenance and economic and reasonable technology.

Cable laying is divided into underground direct burial laying, protection conduit laying, cable trench laying, tunnel laying, underwater laying and laying along the wall, etc. Selection of cable laying method depends on engineering conditions, environmental characteristics, cable type and quantity, and other factors and shall be carried out by adhering to the principles of reliable operation, ease of maintenance and economic and reasonable technology. For laying method of power cable, please refer to GF 50217-2007 Code for Design of Cables for Electric Power Project.

9. Grounding

Grounding of electrical system must be taken into consideration during installation of Gen-set, in order to prevent insulation of electrical equipment on the Gen-set from being damaged or prevent electric shock, personal injuries or even death caused by electrification of exposed current-carrying part which is usually not live when any leakage current is produced. Besides, casing of the Gen-set shall be grounded, in order to provide personnel protection for operators.

In order to improve reliability of electricity utilization, neutral point grounding generally is not recommended. It will not cause an accident when one phase of ungrounded power supply system is grounded. And, operation will not be influenced when there is no voltage between only this phase and ground. No accident will be caused if this can be discovered timely; if above phenomenon occurs in the power supply system in which only the neutral point is grounded, it would cause tripping and striking of sparks at grounding point, or even gas explosion.

Warning: incorrect grounding would cause personal injuries, or even death.

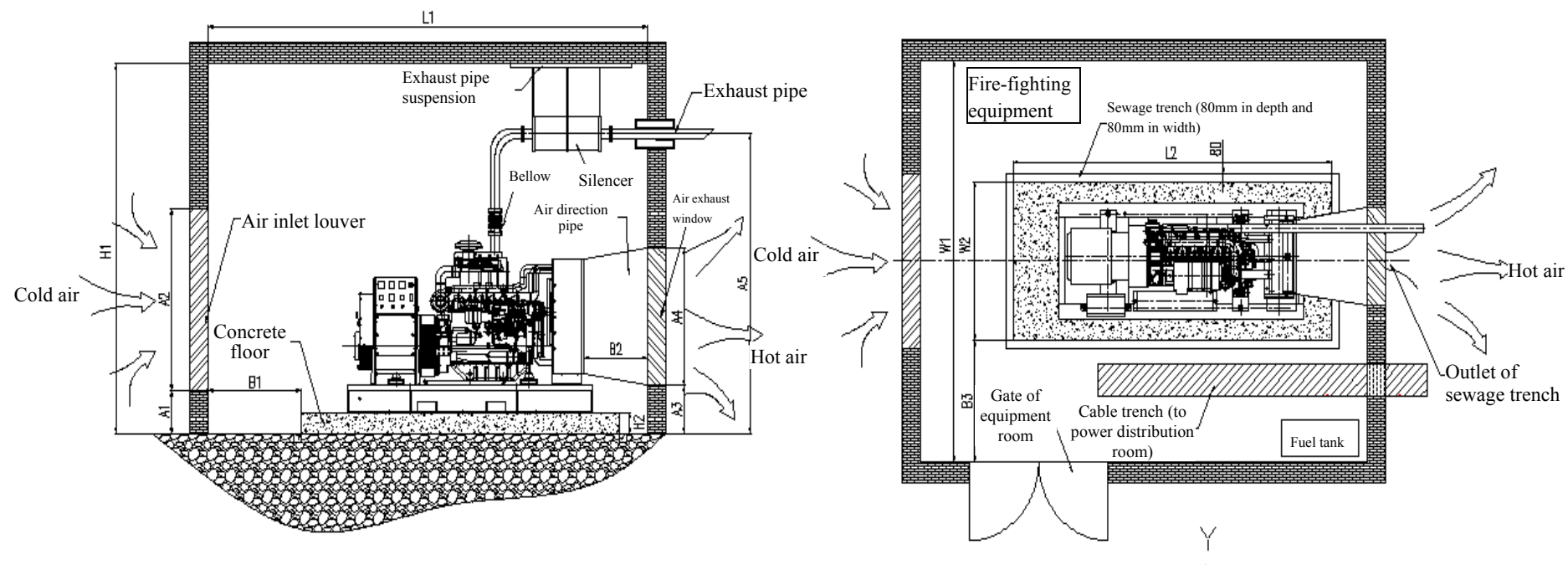
10. Other requirements

Sewage discharge: during operation and maintenance of Gen-set, water and oil sewage needs to be discharged and sewage trench shall be designed in order to discharge sewage;

Fire protection: equipment room shall be equipped with fire extinguishers.

Lighting facilities: equipment room shall be equipped with necessary lighting facilities.

III. Standard equipment room arrangement of the Gen-set



Chapter 7 Commissioning of the Gen-set

Carry out commissioning as per following methods after the Gen-set is installed:

I. Inspections before commissioning

1. Areas at around Gen-set shall be cleaned up and unsafe objects shall be moved away, in order to prevent operation from being influenced or danger from being caused and ensure that intake/exhaust duct for ventilation of equipment room is not blocked;

2. Before inspection, check if key switch of control panel is “OFF” and emergency stop switch is “ON”;

3. Check all electric circuits to see if wiring harness is damaged or leaks electricity or not. If any, replace the wire; and, check if the connection is loose or damaged or not. If any, tighten or replace it.

4. Check reliability of fasteners and throttle control system, confirm if various operating mechanisms are flexible, portable and reliable and check pre-tensioning of charger belt and fan belt;

5. Check if there is large amount of dust accumulating on control panel and Gen-set. If any, clean it in order to prevent electric shock or reduction of cooling performance of the Gen-set caused by these dust and impurities.

6. Check if electrodes of battery are corroded or not. If any, clean it. Check voltage of battery, if it is less than 9V(12V system) or 19V (24V system) and does not meet starting requirements, charge the battery.

Warning: do not place wrench, iron pipe or conductors on battery because this is easy to cause short connection of positive and negative electrode of battery and accidents.

Danger: when cleaning battery, do not smoke or carry out fire-related works nearby because the hydrogen generated during electrolysis of battery may cause an explosion.

7. Check restriction indicator of air filter and clean the filter if restriction display appears.

8. Check if air switch of the Gen-set is off.

II. Preparations before commissioning

1. Refilling of coolant

1.1 Coolant selection

Generally, anti-freeze is used as coolant of the Gen-set. Anti-freeze is one kind of coolant containing special additives.

Anti-freeze refilled in engine has following functions:

- 1) Ensure that engine operates in a normal temperature range;
- 2) Prevent corrosion of parts in cooling system;
- 3) Prevent water scale and avoid efficiency reduction of radiator;
- 4) Effectively prevent “boiling” of water tank in summer;
- 5) When stopping the Gen-set while ambient temperature in winter is low, be sure to prevent radiator and cylinder block or head of engine from being damaged by expansion of frozen coolant. The anti-freeze to be selected will be different when ambient temperature is different. For details of coolant grade, please see Table 7-1.

Table 7-1 Domestic long-life anti-freeze

Item	Grade		
	JFL-318	JFL-336	JFL-345

Content of ethylene glycol (%)	33	50	56
Specific gravity (15.6°C)	1.05	1.074	1.082
Boiling point °C	104.5±1	108.5±1	110±1
Freezing point °C	-18±1	-36±1	-45±1
Applicable minimum air temperature °C	-10	-26	-35

Note: do not only use water as the coolant.

Note: anti-freeze shall be stored at a dry and cool place and kept away from bright sunlight.

1.2 Method for refilling of coolant

Slowly fill coolant into cooling system from filler on radiator until level of coolant in radiator is 5cm away from filler, in order to bleed residual air in cooling system of engine.

2. Refilling of oil

2.1 Oil selection

Owing to the fact that viscosity of engine oil depends on temperature to a large extent and will reduce significantly with increasing of temperature, in order to ensure that diesel engine can be operated in a safe and reliable way, please select the most appropriate engine oil according to ambient temperature by referring to figure 7-1.

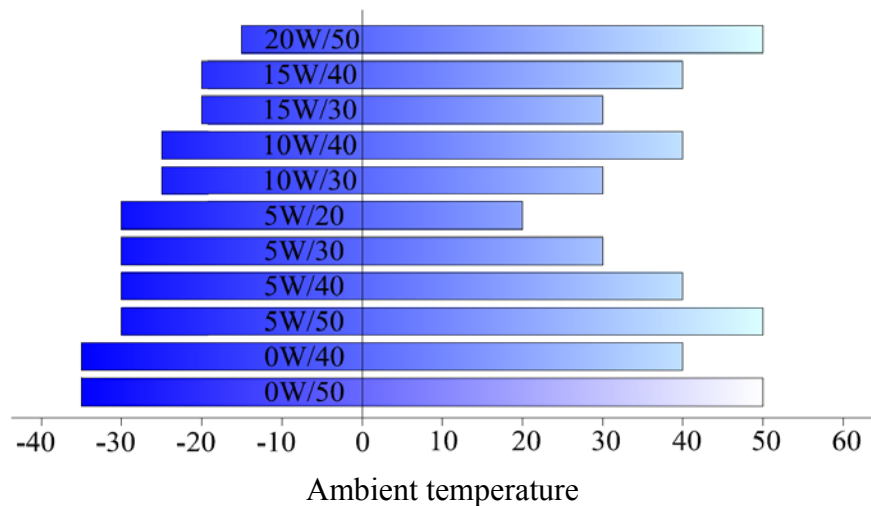


Figure 7-1 Selection of lubricating oil grade

In China, it is recommended to select lubricating oil grade as below:

- Select SAE5W/30 grade lubricating oil in northern region;
- Select SAE15W/40 grade lubricating oil in Central China;
- Select SAE20W/50 grade lubricating oil in southern region.

You are recommended to use Weichai Power's dedicated 15W-40 engine oil which is mixed with imported high-quality base oil and well-chosen additives and sold by various service outlets at a unified price in China.

Note: do not use CD grade or below lubricating oil on the Gen-set. Be sure to replace engine oil filter every time the engine oil is replaced!

Note: using of lubricating oil which does not meet above requirements may cause operation loss and reliability performance reduction of the Gen-set.

Warning: the engine using lubricating oil of incorrect type or quality grade is beyond the scope of warranty.

2.2 Method for refilling of oil

Refill engine oil to lubrication system from engine oil filler at cylinder head of

diesel engine and detect engine oil level by the dipstick on oil pan. The level shall be proper when it is higher than L (lower level) scale mark and lower than H (higher level) scale mark.

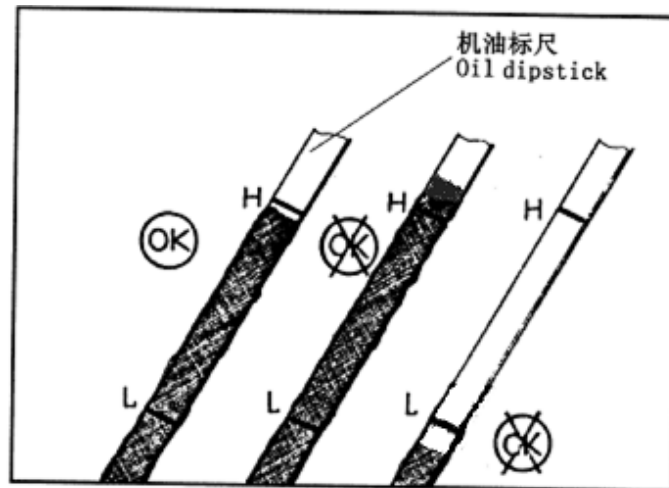


Figure 7-2 Engine oil level

3. Refueling

3.1 Fuel selection

Selection of grade (as per GF252-2000) is as shown below:

No.10 light diesel oil: applicable for diesel engine with preheating equipment;

No.5 light diesel oil: applicable for the regions where lowest air temperature is above 8°C;

No.0 light diesel oil: applicable for the regions where lowest air temperature is above 4°C;

No.-10 light diesel oil: applicable for the regions where lowest air temperature is above -5°C;

No.-20 light diesel oil: applicable for the regions where lowest air temperature is above -14°C;

No.-35 light diesel oil: applicable for the regions where lowest air temperature is above -29°C ;

No.-50 light diesel oil: applicable for the regions where lowest air temperature is above -44°C ;

3.2 Method for refueling

Fill fuel to daily-use fuel tank fully. In the Gen-set, the light diesel oil of specified grade and sulfur content is not higher than 0.5% shall be used as the fuel.

Warning: when filling fuel to fuel tank, do not smoke or use open flame nearby because this usually would cause a risk of fire or explosion.

3.3 Fuel system bleeding

During first commissioning of the Gen-set, be sure to check and confirm that there is no air in fuel at first. If there is any air, bleed it as per following methods.

1) Bleed air in low pressure fuel pipe

Loosen bolts and press oil delivery pump with hands to bleed air in fuel loop until the air is bled. Then, stop this operation and tighten bolts.

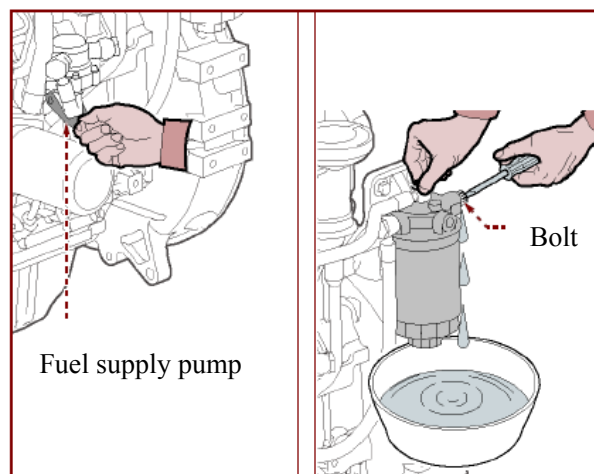


Figure 7-3 Air bleeding of low pressure fuel pipe

2) Bleed air in high pressure fuel pipe and fuel pump

Loosen nuts and drive diesel engine to rotate with starter to bleed air in fuel pump and high pressure fuel pipe until fuel flows from high pressure fuel pipe continuously. Then, stop the operation and tighten nuts.

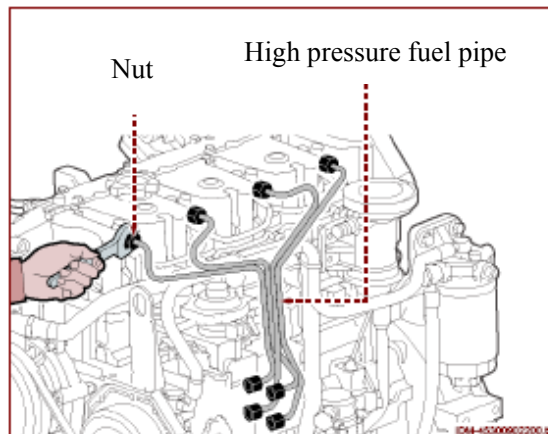


Figure 7-4 Air bleeding of high pressure fuel pipe

4. Check if all pipelines and joints in fuel supply system, lubrication system, cooling system and other systems of diesel engine are free from fuel leakage and water leakage.

5. Connection of loaded cable

Connect loaded power cable to air switch of the Gen-set according to following requirements:

1) Tighten with bolt assembly (in the order of bolt, spring washer, flat washer, connector and nut), in order to ensure that connection wires contacts with each other well;

2) Phase sequence of loaded power cable shall be kept consistent with phase sequence (U, V, W and N) of air switch;

3) Be sure that these phases contact with each other well and short connection is

prohibited;

- 4) Air switch is in switching-off state.

6. Testing insulation resistance

- 1) Open outlet box cover plate of alternator to remove wiring on main stator (armature) of alternator AVR, namely No.7 and No.8 wiring of AS440 and AS480 (for SE350, remove No.3 and No.4 wiring);

- 2) Disconnect grounding conductors between all neutral wires and grounding wires;

- 3) Measure insulation resistance to ground of leading-out terminal U, V and W in turn with a 500V mega-ohm meter or other similar instruments;

- 4) Measure insulation resistance to ground of excitation stator (magnetic field), namely insulation resistance to ground of F1 and F2 wiring on AS440 and AS480 (for SE350, measure insulation resistance to ground of F+ and F-);

- 5) The resistance value shall be greater than $5M\Omega$. If not, be sure to dry the coil by referring to the drying method specified in Chapter 9.

7. Connecting negative battery cable

Connect negative battery cable to battery and protect it with insulation protection cap.

III. Commissioning of the Gen-set

1. Start capacity

Turn power switch  on control panel to “ON” position at first and the control panel display module shall be able to display normally; for mechanically governing diesel engine, stop electromagnet operates to turn stop handle to fuel supply position; observe battery voltage from display screen and connect mains

power to terminal block “L1” and “N1” of control panel if the voltage is lower than 9V(12V system) or 19V (24V system) , in order to recharge the battery.

Finally, press  manual mode button on control panel to switch to the manual mode, and LED indicator light turns on. After the controller is in manual mode, press  start button again to start the Gen-set manually; if you want to stop the Gen-set, press  stop button. After safety supervision delay time is over, “Gen power on” indicator light on controller turns on, indicating that the engine is operating.

For automatic/self-switching Gen-set, the Gen-set will simulate mains power failure after the Gen-set is switched to AUTO mode  and mains power test mode button is pressed. After being started, the Gen-set will supply power to loads. If you want to stop the Gen-set, press  stop button.

Note: do not start the Gen-set when being loaded, namely air switch shall be in switching-off position when the Gen-set is started.

Note: if starting is not successful, try again approximately 20s later. If starting does not realized continuously for 3 times, top starting and try again after battery voltage or fuel pipe, etc. related trouble factors are eliminated.

2. Operating capacity

2.1 Operation under idle speed

After the Gen-set is started successfully, operate it under rated conditions to check operating state of the Gen-set. Main checking contents are as follows:

1) Check if speed of the Gen-set is normal or not by viewing display screen of the module and it shall be approximately 700r/min under idle operation;

2) Check if oil pressure of the Gen-set is normal or not. The oil pressure shall not be lower than 0.15Mpa;

3) Check if pipeline of fuel, lubrication and cooling system leaks or not;

4) Check if there is any abnormal noise or vibration and check connection and fastening condition of various parts;

5) Check if exhausting is normal or not. Belching of small amount of black smoke immediately after starting of the Gen-set is normal.

2.2 Operation under Rated speed

If the Gen-set is equipped with idling/rated speed switch and operates normally after being started, turn throttle control handle of diesel engine to “RATED SPEED” position and lock it after the Gen-set has operated under idling state for 3~5min.

If the Gen-set is not equipped with idling/rated speed switch, the Gen-set will automatically increase to rated speed in about 30~45s after being started.

After the Gen-set reaches to rated speed, check operation state of the Gen-set again. Main checking contents are as follows:

1) Check speed and frequency of the Gen-set (normal speed and frequency of the Gen-set is separately 1530~1560r/min and 51~52Hz). If speed and frequency of diesel engine is lower than 1,530r/min or 51Hz and speed of diesel engine is governed mechanically, adjust and lock throttle control handle to increase speed of diesel engine to approximately 1530~1560r/min (frequency 51~52Hz);

2) Check voltage of three-phase output line of the Gen-set. Voltage of each line shall be 400V;

3) Check if water temperature and oil pressure of the Gen-set is normal or not. Water temperature shall be lower than 95℃ and oil pressure shall be higher than

0.15Mpa;

4) Check if lines of fuel, lubrication and cooling system leak or not;

5) Check if belched smoke is normal. Belched smoke of the Gen-set shall be colorless. It is abnormal if large amount of black smoke, blue smoke or white smoke is belched from this diesel engine.

2.3 Operation with load

If the Gen-set operate normally, let the Gen-set operate under rated speed for 3~5min and close breaker after the Gen-set warms up to let the Gen-set operate under load. At this time, inspect operating condition of the Gen-set. The main inspection items are as follows:

1) Check speed and frequency of the Gen-set (normal speed and frequency of the Gen-set is separately 1530~1560r/min and 51~52Hz). If speed and frequency of diesel engine is lower than 1,530r/min or 51Hz and speed of diesel engine is governed mechanically, adjust and lock throttle control handle to increase speed of diesel engine to approximately 1530~1560r/min (frequency 51~52Hz); if speed of diesel engine is governed electronically and it is necessary to adjust speed, open throttle body of control panel and adjust speed fine-adjusting positioner;

2) Check voltage of three-phase output line of the Gen-set. Voltage of each line shall be 400V;

3) Check three-phase current of the Gen-set by ampere meter and three-phase current change-over switch and the measured current value shall not exceed rated current of the Gen-set;

4) Check if water temperature and oil pressure of the Gen-set is normal or not. Water temperature shall not be lower than 95℃ and oil pressure shall be higher than 0.15Mpa;

5) Check if belched smoke is normal. Belched smoke of the Gen-set shall be colorless. It is abnormal if large amount of black smoke, blue smoke or white smoke is belched from this diesel engine.

Note: never increase load rapidly when coolant temperature is not higher than 60°C.

3. Stop capacity

3.1 Normal stop

1) Remove loads at first, proceed to switching-off operation and let the Gen-set operate without load for 3~5 minutes after being unloaded;

2) Press stop button , stop electromagnet operates, pull stop handle to stop position to stop operation of the Gen-set;

3) Finally, turn power switch to “OFF” position to cut off power supply of the entire control system;

4) Remove connecting cable from negative electrode of battery and protect it with insulation tape.

3.2 Emergency stop

In an emergency stop, press emergency stop button or rapidly push fuel injection pump stop control handle to “OFF” position.

Note: do not activate emergency stop at random unless a special emergency occurs.

If any abnormality occurs during commissioning, carry out troubleshooting with the method introduced in Chapter 10.

Chapter 8 Operation of the Gen-set

I. Preparations and inspections before operation

1. Areas at around Gen-set shall be cleaned up and unsafe objects shall be moved away, in order to prevent operation from being influenced or danger from being caused and ensure that intake/exhaust duct for ventilation of equipment room is not blocked;

2. Before inspection, check if key switch of control panel is “OFF” and emergency stop switch is “ON”;

3. Check all electric circuits to see if wiring harness is damaged or leaks electricity or not. If any, replace the wire; and, check if the connection is loose or damaged or not. If any, tighten or replace it.

4. Check reliability of fasteners and throttle control system, confirm if various operating mechanisms are flexible, portable and reliable and check pre-tensioning of charger belt and fan belt;

5. Check if there is large amount of dust accumulating on control panel and Gen-set. If any, clean it in order to prevent electric shock or reduction of cooling performance of the Gen-set caused by these dust and pollutants.

6. Check if electrodes of battery are corroded or not. If any, clean it;

7. Check restriction indicator of air filter and replace the filter if restriction display appears.

8. Check level of fuel, engine oil and coolant in the Gen-set. Carry out refilling when the level is low;

9. Check if all pipelines and joints in fuel supply system, lubrication system, cooling system and other systems of diesel engine are free from fuel leakage and water leakage.

10. Make sure that air switch of the Gen-set is OFF;

11. Connect negative battery cable.

II. Operation of the Gen-set

1. Starting of the Gen-set

Turn power switch  on control panel to “ON” position at first and display module of control panel is able to display various parameters normally; then, stop electromagnet operates and push stop handle to fuel supply position.

Press  manual mode button and indicator light turns on when manual mode is switched to. After the controller is in manual mode, press  start button again to start the Gen-set; Check if the Gen-set operates normally or not and then press stop button , the Gen-set will stop after operation without load at rated speed for 120s. If you want to stop the Gen-set directly, press stop button two times directly.

Note: do not start the Gen-set when being loaded, namely air switch shall be in switching-off position when the Gen-set is started.

Note: if starting is not successful, try again approximately 20s later. If starting does not realized continuously for 3 times, top starting and try again after battery voltage or fuel pipe, etc. related trouble factors are eliminated.

2. Operation of the Gen-set

2.1 Normal start

After the Gen-set is started successfully, operate it under rated conditions to check operating state of the Gen-set. Main checking contents are as follows:

1) Check speed and frequency of the Gen-set (normal speed and frequency of the Gen-set is separately 1530~1560r/min and 51~52Hz);

2) Check three-phase output voltage of the Gen-set with voltmeter and

three-phase voltage change-over switch. The value shall be 400V;

3) Check if water temperature and oil pressure of the Gen-set is normal or not. Water temperature shall be lower than 95°C and oil pressure shall be higher than 0.15Mpa;

4) Check if lines of fuel, lubrication and cooling system leak or not;

5) Check if belched smoke is normal. Belched smoke of the Gen-set shall be colorless. It is abnormal if large amount of black smoke, blue smoke or white smoke is belched from this diesel engine.

2.1 Operation with load

If the Gen-set operate normally, switch on breaker after the Gen-set warms up at Rated speed to let the Gen-set operate under load. At this time, inspect operating condition of the Gen-set. The main inspection items are as follows:

1) Check speed and frequency of the Gen-set (normal speed and frequency of the Gen-set is separately 1530~1560r/min and 51~52Hz).

2) Check three-phase output voltage of the Gen-set and the value shall be 400V;

3) Check current of the Gen-set and this current shall not exceed rated current of the Gen-set;

4) Check if water temperature and oil pressure of the Gen-set is normal or not. Water temperature shall be lower than 95°C and oil pressure shall be higher than 0.15Mpa;

5) Check if belched smoke is normal. Belched smoke of the Gen-set shall be colorless. It is abnormal if large amount of black smoke, blue smoke or white smoke is belched from this diesel engine.

Note: it is necessary to check operation state of the Gen-set every 1 hour.

Note: be sure to switch on air switch under supervision of power

distribution personnel only after confirming that electric equipment can be powered by the Gen-set.

Note: make sure that load does not exceed rated power of the Gen-set.

Note: be sure that the Gen-set is not operated under no-load state continuously for more than 30 minutes, in order to prevent leakage of lubricating oil of the Gen-set.

Warning: do not try to touch exhaust pipe, turbocharger, high-temperature coolant & heater and other high-temperature surfaces of the Gen-set with your hands when the Gen-set is operating, or your hands would be burnt!

Warning: never remove any component of the Gen-set when the Gen-set is operating!

Warning: when the Gen-set is operating, do not put your hands under protective cover of fan or other parts which move relatively!

3. Warning of the Gen-set

Warning is not a serious alarm condition which would not have an impact on system operation of engine, but only is used to remind operators of the conditions that do not meet with requirements. When any warning occurs, display panel will display corresponding trouble problems. If these troubles are not locked, the warning will be removed once these troubles are eliminated. After troubles are eliminated, press stop/reset button  to release stop locking, corresponding warning indicator light will turn off and Gen-set is able to be started for commissioning.

4. Stop of the Gen-set

4.1 Normal stop

1) Remove loads at first, proceed to switching-off operation and let the Gen-set operate without load for 3~5 minutes after being unloaded;

2) Press stop button  and the Gen-set will stop operating after 2 minutes (the mechanically governing Gen-set will operate 2 minutes under rated conditions, while electronic governing Gen-set will operate 2 minutes under idle mode);

3) If you want to stop the Gen-set directly, press stop button  two times successively;

4) Turn power switch to “OFF” position;

5) Remove connecting cable from negative electrode of battery and protect it with insulation tape.

Note: never stop the Gen-set operating with loads.

4.2 Emergency stop

In an emergency stop, the Gen-set will turn off throttle immediately after emergency stop button is pressed or fuel injection pump stop control handle is rapidly pushed to “OFF” position. Emergency stop signal will be released only this button is pressed again.

Emergency stop must be activated immediately after any of the followings occur during operation of Gen-set.

1) Any abnormal sound or odor is heard or sensed during starting or operation of the Gen-set;

2) Oil pressure of the Gen-set suddenly reduces to the limit or no oil pressure is detected;

3) Speed of the Gen-set is 115% higher than rated speed;

4) Fire, electric leakage or other natural disasters that may endanger safety of the Gen-set and operators occurs.

Note: do not activate emergency stop at random unless a special emergency

occurs.

Chapter 9 Maintenance and Care of the Gen-set

I. Maintenance and care schedule

Interval	Contents
Daily	Clean oil stains and dust on Gen-set
	Check level of diesel oil, engine oil and coolant
	Check if there is any air, oil or water leakage
	Check if all electric circuits are getting loose or damaged or not
	Clean dust in dust exhausting bag of air filter
50h (One-time, does not need to be repeated)	Change engine oil and element of oil filter
	Clean fuel filter and element
	Check belt and tension
	Clean air filter
	Apply universal auto lithium base lubricating grease to water pump bearing
	Clean dirt on electric brush and commutator of starter and lubricate bearing of alternator
200h	Change engine oil and element of oil filter
	Check water dropping condition at drain hole of water pump. If it is severe, replace the water seal
	Check if alternator and starter are installed firmly and check if electric brush or commutator is worn or not
	Check if wire joints of electrical apparatus are connected firmly and replace it when any burn mark is found
	Check valve clearance and adjust it to specified value
	Clean parts of breather
	Check if element of air filter is in good condition or not.
	Check insulation resistance of alternator winding and dry it if it is too low
	Clean air filter of Gen-set
500h	Replace element and seal ring of fuel filter
	Clean daily-use fuel tank and various fuel passages
	Replace element of air filter

	Clean radiator
	Clean oil cooler or replace core of oil cooler if it is blocked
	Check and adjust angle of advance
	Check tightness of air valve
	Check if crankcase blows by and if belched some is blue, replace piston ring when necessary.
	Check wear of cylinder jacket, connecting rod bearing shell and main bearing shell, etc.; and clean carbon deposit on cylinder head, piston, combustion chamber and cylinder jacket.

II. Maintenance and care operation

1. Checking fuel, engine oil and coolant level

Fuel level: never operate the Gen-set when fuel level is lower than lower scale mark. Fill proper amount of diesel oil into chassis fuel tank or daily-use fuel tank.

Engine oil level: as shown in Figure 9-1, never operate the Gen-set when engine oil level is lower than L (low level) scale mark or higher than H (high level) scale mark. When engine oil level is lower than L (low level) scale mark, fill engine oil of the same grade until the level is between L and H scale marks; when engine oil level is higher than H (high level) scale mark, drain proper amount of engine oil until the level is between L and H scale mark.

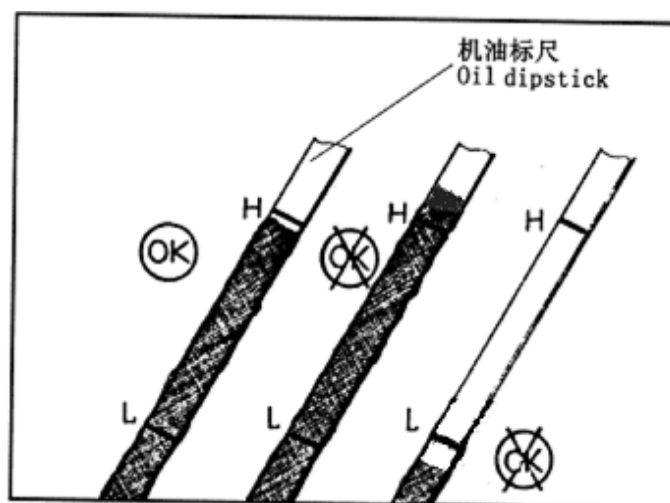


Figure 9-1 Engine oil level

Coolant level: when coolant level is low, fill proper amount of coolant into water tank until coolant level in radiator is 5cm below filler.

2. Replacing engine oil and oil filter element

Replacement is necessary after first 50 hours operation of the Gen-set. Then, replacement is necessary every 200h operation as per following specific procedures:

2.1 Start the Gen-set until water temperature reaches to 60°C. Then, stop the Gen-set and prepare a vessel to collect drained engine oil. Immediately open oil drain valve on oil pan to drain engine oil and impurities fully, during which burns shall be paid attention to and prevented.

2.2 Remove oil filter with tools, clean surrounding of filter cover, clean surface of seal ring (or replace when necessary) and remove the O-ring that may closely attach on the rover.

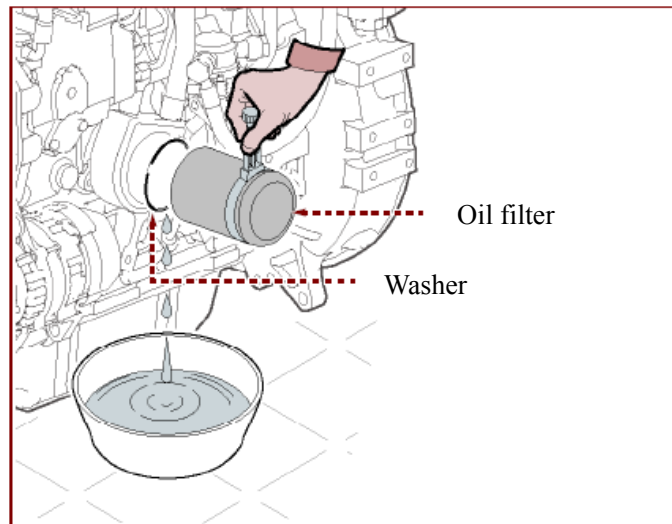


Figure 9-2 Replacing oil filter

2.3 Operate filter correctly and fill clean lubricating oil in a new filter fully, or the engine would be damaged because of short-time oil shortage.

2.4 Apply a thin layer of lubricating oil on surface of seal ring before installing

new filter.

2.5 Install filter to filter cover and then tighten it until washers contact with surface of filter cover closely. Then, retighten it 3/4~1 turn(s) more to seal it up.

2.6 Check and clean drain plug and washers and then reinstall and retighten them.

2.7 Fill new lubricating oil until its level is between the upper and lower scale mark of oil dipstick.

2.8 Start the Gen-set and keep it idle after engine oil is replaced to check if drain plug or filter leaks or not.

2.9 Check level of engine oil again 5 minutes after stopping. If oil level lowers to below lower scale mark, refill lubricating oil until the level is between the upper and lower scale mark of oil dipstick.

3. Replacing fuel filter

3.1 Turn off the engine to let it cool down, in order to avoid damage from heat.

3.2 Prepare a vessel to collect leaked fuel.

3.3 Remove filters with dedicated tools.

3.4 Fill fuel to a new fuel filter.

3.5 Apply lubricating oil to surface of filter seal ring before installation.

3.6 Install filter with special tools and retighten the seal ring 3/4~1 turn(s) more after it contacts with base, in order to seal it up.

4. Cleaning air filter element

The maximum intake resistance of diesel engine must be inspected when it operates at rated speed and full load. When intake resistance reaches to the maximum allowable limit, clean or replace filter element.

Note: never operate the engine when no air filter is provided, or dust and impurities would enter into diesel engine and cause early wear of engine.

Remove filter element from air filter and gently pat end face or flush reversely (from inside to outside) with compressed air to remove dust, as shown in Figure 9-3.

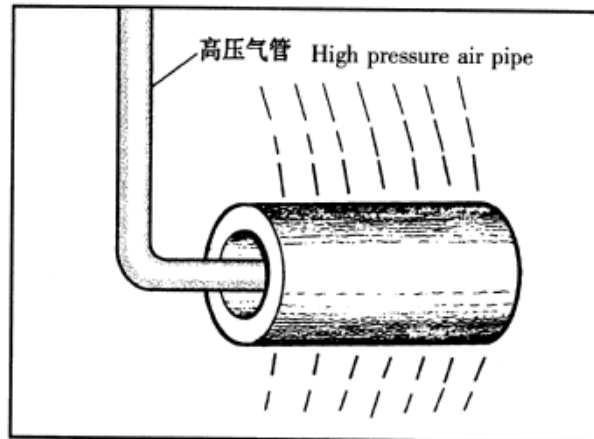


Figure 9-3 Cleaning of air filter

Note: do not damage the filter paper while flushing, wash filter paper with water or oil, or pat or knock element with force.

5. Cleaning radiator

5.1 External cleaning of radiator

In a dusty environment, blades of radiator would be blocked by dust and debris, etc., and then performance of radiator will be influenced further. The common method to remove these tiny impurities is to spray low-pressure steam flow into it.

The impurities which are difficult to be removed shall be cleaned by adding detergents in low-pressure hot water hose. If some of the sediments which are difficult to be removed still cannot be solved by above methods, it is necessary to remove the removed and immerse into a hot alkaline degreasing solution for about 20 minutes, and then flush it with a hot water pipe.

5.2 Internal cleaning of radiator

The entire system would be blocked by rust scale because of leakage, etc., hard water in filled water or operation of the Gen-set without anti-rust agent.

Rust cleaning procedures of radiator are as follows:

1) Drain water in the system, remove and close interface connecting pipes and oil engine.

2) Prepare anti-acid solvent at the concentration of 4% and fresh water, add anti-acid solvent into water and pay attention to not reverse the order.

3) After several minutes of mixing, heat the solution to 49°C or under.

4) Slowly pour the solution into radiator from a nozzle or bypass pipe, then bubbles will appear. After these bubbles disappear, fill the radiator with hot solution fully.

5) Keep the radiator vertical for several minutes and then drain the solution to its original container from branch pipe or drain plug at bottom.

6) Check if there is any rust scale in water tank. If any, increase concentration of the solvent to 8% and repeat above procedures.

7) After rust removal, neutralize this acid solution in the following way: mix 0.5kg soda with 20 liter water, fill the solution into water tank of radiator and then drain it to its original container.

8) After multiple flushing of above, keep water tank of radiator fully with water for at least 1 hour and then drain water in it. Finally, flush water tank of radiator again with fresh hot water.

9) When reusing the radiator, fill water tank with water and carry out pressure test at a pressure which is two times of operating pressure, then carefully check if there is any leakage caused by rusty scale.

10) Before commissioning once again, mix coolant with necessary anti-rust and

anti-corrosion agents or anti-freeze of proper proportion.

6. Drying of alternator

6.1 Cold-state operation

If a normal alternator is left out of operation for a long period of time in a dusty and moisture environment, simply operate the Gen-set with connecting wire (F1 and F2 connecting wire of AS440 and AS480, F+ and F- connecting wire of SE350) of excitation stator (magnetic field) of AVR is disconnected for 10 minutes or longer. Just by this, the requirement to dry winding surface and increase insulation resistance value to 1 MΩ or higher so as that the Gen-set can be used for normal operation directly can be met.

6.2 Drying by introducing air

Remove all cover plates on alternator, in order that moist air can run away. During the process of drying, air stream shall be able to freely flows in the alternator and bring away moisture.

Please introduce hot air into alternator from its air intake with two 1~3kW electric hair dryers. Pay attention that winding shall be kept at least 300mm away from heat source, in order to avoid damage of insulation caused by overheating.

Heat continuously and record insulation resistance value once every half hour. The drying process will be completed when the resistance reaches to the valued specified in “typical drying curve”.

Start the Gen-set again for commissioning after removing these heaters and reinstalling all cover plates.

If the Gen-set does not operate immediately, make sure that condensation removing heater installed on alternator is energized and operates normally. Measuring of insulation resistance is still necessary before starting of operation next time.

6.3 Short connection method

Note: this process must be carried out by a qualified engineer who is familiar with safe operation procedures of malfunctioned Gen-set.

At first, carry out all mechanical and electrical safe operations related to the Gen-set and site, in order to ensure operation safety of alternator.

Complete short connection of output end of Gen-set with short-circuit plates which can withstand rated current of alternator.

Disconnect connecting wires (F1 and F2 connecting wire of AS440 and AS480, F+ and F- connecting wire of SE350) of excitation stator (magnetic field) on AVR.

Add a direct-current electrical source between the disconnected two conductors (connect F1 or F+ to positive electrode and connect F2 or F- to negative electrode) and this direct-current electrical source must be adjustable in a range of 0~24V and is able to provide 2.0A current to an extreme.

Connect a proper AC ammeter to measure short-circuit current.

Adjust voltage of direct-current power source to zero at first and then start the Gen-set. Increase direct-current voltage slowly so as that current flows in coil of excitation stator (magnetic field). When excitation current increases, the stator current in short-circuit state will increase also. Be sure to measure current of stator so as that it is not 80% higher than rated current.

Please perform following measurements every 30 minutes:

Stop the Gen-set, disconnect externally connected exciting DC power source, and then measure, record and tabulate insulation resistance of stator coil. The measured figure shall be compared with typical curve and the drying process will be completed when insulation resistance reaches to the value specified in “typical drying curve”.

Once the insulation resistance reaches to $1\text{M}\Omega$, remove the DC power source and reconnect magnetic field lead of exciter (F1 and F2 connecting wire of AS440

and AS480, F+ and F- connecting wire of SE350) to terminal of AVR. Restore the Gen-set and reinstall all cover plates to carry out commissioning of the Gen-set again.

If the Gen-set does not operate immediately, make sure that condensation removing heater installed on alternator is energized and operates normally. Measuring of insulation resistance is still necessary before starting of operation next time.

Warning: never carry out short connection of three-phase winding when AVR and alternator is connected to a loop as winding will be damaged when current exceeds rated current of the alternator.

6.4 Typical drying curve

No matter the alternator is dried by what way, record insulation resistance value once every half hour and tabulate these records into a graph as shown in Figure 9-4.

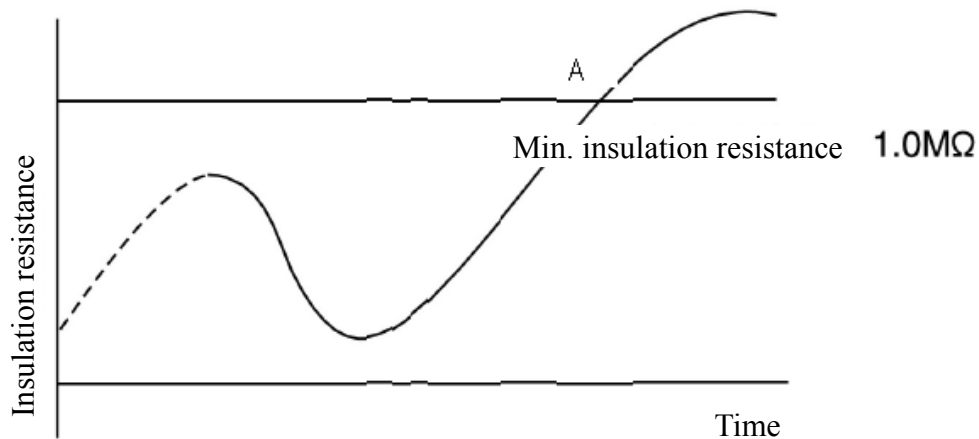


Figure 9-4 Typical drying curve

Figure 9-4 shows typical drying curve of a very humid alternator. This curve shows that insulation resistance reduces and then rises to a stable value gradually after rising for a short period of time. Insulation resistance under stable state at point A must be higher than 1 MΩ. (If winding is only lightly affected with damp, it may not be observed at dotted line part in the figure).

The drying process will at least last 1 hour when “A” point is reached.

Note: insulation resistance will reduce significantly when temperature of winding rises. References of above insulation resistances are values measured when temperature of winding is 20°C.

If insulation resistance is still lower than 1MΩ after above drying process, carry out polarization test of coil.

If all parts cannot meet the requirement of 1MΩ insulation resistance, wind the coil again or clean alternator again.

Never put the alternator into service when minimum insulation resistance requirement is not met.

Measurement of insulation resistance shall be carried again after winding is dried up, in order to ensure that the above minimum resistance requirement can be met.

7. Cleaning method of air filter on alternator

Warning: live parts would be contacted when removing parts of air filter, so removal of these parts is allowable only after stopping.

Remove parts of air filter from air filter cover and soak or wash these parts with proper oil removal agent until these parts are fully cleaned. In addition, dry these parts fully before being reinstalled.

8. Maintenance of the Gen-set

The engine and AC alternator would be damaged when the Gen-set is not used for a long period of time. Correct storage of the Gen-set may reduce this damage to the minimum.

8.1 It is the optimal if the Gen-set is placed in an environment in which ambient temperature is 20°C~25°C, relative humidity is 20%~70% and air pressure is 70kPa~106kPa.

8.2 Before sealing-up, all rusts shall be removed with proper methods and all parts (lubricating oil line, fuel system and supercharger, etc.) treated with protective agent shall be cleaned completely. Protection procedures of the Gen-set are as follows:

1) After the Gen-set is warmed up, clean engine oil filter and add anti-rust oil to oil pan of diesel engine.

2) Drain all diesel oil in fuel system and fill a mixture of 90% diesel oil and 10% anti-rust oil to protect the entire fuel lines. The mixture must be mixed fully before being filled.

3) If the diesel engine is not filled with cooling emulsion, fill cooling emulsion and anti-rust oil protecting cooling jacket after cooling water is drained. Before sealing-up and after filling of above emulsion, start the Gen-set as per starting procedures and let it idle for 15~25 minutes.

4) Remove cover plate on short face of intake pipe, spray anti-rust oil to intake pipe with a pressure nozzle. Rotate crankshaft with hand when spraying oil, in order to open air valve and let anti-rust oil flow into combustion chamber. Do not rotate crankshaft anymore once all sealing-up works are completed, in order to prevent oil film attached on cylinder wall from being scratched off.

5) Drain various oils and fluids in diesel engine, drain or pump anti-rust oil from engine base, drain emulsion from cooling system and keep all draining switches open.

6) Remove rocker arm cover to spray anti-rust oil to valve spring and rocker arm.

7) Be sure to spray protective oil to all machined parts and parts easy to be rusted on diesel engine.

8) Nozzle of intake and exhaust pipe (silencer) shall be closely wrapped with a

piece of plastic cloth to prevent foreign objects and moisture from entering into.

9) Seal up after above procedures are completed.

8.3 If AC alternator is not used for a long period of time, moisture may enter into the coil and cause corrosion. In order to reduce condensation of moisture as much as possible, place AC alternator at a dry place and keep its coil dry with a moisture remover if possible.

8.4 Followings shall be paid attention to during storage of battery: it shall be kept in a dry, clean and well-ventilated room in which temperature is 5~25℃; be kept away from direct sunlight, heat source, any liquid and hazardous substances; do not be placed upside down or on the side; and prevent from being impacted or weighted.

After long period of service, the battery itself may discharge slowly, or even scrap. Therefore, in order to ensure that the battery is always in good operating state, recharge it at regular intervals.

Suggested charging interval is as follows:

Recharge once every 6 months when storage temperature is less than or equal to 20℃;

Recharge once every 3 months when storage temperature is 20~30℃;

Chapter 10 Common Failures and Troubleshooting

1. Diesel engine does not start

No.	Causes	Troubleshooting
1	Starting system fails-starter does not operate	
	Power of control system is not connected	Connect power of control system
	Battery is low in level or damaged	Recharge or replace the battery
	Fuse in control chamber operates	Replace fuse
	Line fault	Tighten loose connecting wire and

		replace aged cable
	Starting motor malfunctions	Contact with after-sale service personnel to maintain or replace.
2	Fuel supply system fails- starter operates, but diesel engine does not start	
	No fuel in fuel tank	Refill diesel oil into daily-use fuel tank
	Stop handle is in stop position and does not operate during starting	Check relay and line troubles
	Stall controller malfunctions	Contact with after-sale service personnel to maintain or replace.
	There is air in fuel supply system	Bleed air in fuel system (see Chapter 7 for specific method)
	Fuel filter is blocked	Clean air filter (see Chapter 9 for specific method)
	Fuel sucking pipe joint of fuel delivery pump is loose	Tighten fuel sucking pipe joint of fuel delivery pump
	Fuel delivery pump malfunctions	Contact with after-sale service personnel to maintain or replace.
	Fuel injection pump malfunctions	Contact with after-sale service personnel to maintain or replace.
	Fuel injector malfunctions	Contact with after-sale service personnel to maintain or replace.
	There is water in diesel oil	
3	Air intake system malfunction-starter operates, but diesel engine does not start	
	Air intake system leaks air	Inspect and maintain
	Intake manifold is blocked	Clean
	Air filter malfunctions	Clean air filter (see Chapter 9 for specific method)
	Intake or exhaust valve leaks air	Adjust valve clearance
	Air cylinder leaks air	Replace piston ring

2. Diesel engine belches smoke

No.	Causes	Troubleshooting
1	Black smoke-diesel oil is not burnt fully	

	Air filter malfunctions	Clean air filter and replace when necessary
	Intake manifold is blocked	Clean intake manifold and replace when necessary
	Air intake system leaks air	Discover fault point and have it maintained or replaced
	Valve clearance is incorrect	Contact with after-sale service personnel to maintain.
	Insufficient cylinder compression pressure caused by wear of piston ring	Replace piston ring.
	Supercharger malfunctions	Repair or replace supercharger.
	Thin air caused by extremely high temperature or altitude	Consult with sales personnel to correct power of the Gen-set.
	Insufficient fuel injection pressure caused by malfunction of fuel injection pump	Contact with after-sale service personnel to maintain or replace.
	Amount of fuel supplied to fuel injection pump is too large	Contact with after-sale service personnel to adjust.
	Speed governor of fuel injection pump malfunctions	Contact with after-sale service personnel to maintain or replace.
	Fuel supply timing is incorrect	Contact with after-sale service personnel to maintain or replace.
	Fuel injector fails and atomization of diesel oil is poor	Contact with after-sale service personnel to maintain or replace.
2	Blue some-burning of engine oil	
	Too much engine oil is filled to oil pan and enters into combustion chamber when diesel engine operates	Drain surplus engine oil until level of engine oil in oil pan is between H and L oil level of dipstick.
	Clearance between piston and cylinder jacket increases and engine oil enters into combustion chamber after long period of low-load (30% or under) operation	Increase loads properly or select a Gen-set with proper power.
	Piston ring is stuck or worn excessively,	Replace piston ring.

	and less in elasticity, or engine oil enters into combustion chamber	
3	White smoke-there is water in diesel oil	
	Unburned fuel mixture is exhausted with waste gas during initial starting of diesel engine (especially in water or when ambient temperature is low)	Normal phenomenon
	Cylinder jacket cracks or cylinder head gasket is damaged, or cooling water enters into cylinder	Contact with after-sale service personnel to maintain or replace.
	There is water and air in fuel	Replace fuel and add oil-water separator. Bleed air in fuel system according to the method specified in Chapter 7.

3. Engine hunting

No.	Causes	Troubleshooting
1	Fuel supply control rod of fuel injection pump moves inflexibly or normal functioning of regulator is damaged, then amount of pumped fuel fluctuates and operating stability of engine is influenced.	Contact with after-sale service personnel to recalibrate or replace.
2	Contact between parts of speed regulator is too tight and resistance of motion is too large; fuel supply control rod moves inflexibly	Contact with after-sale service personnel to maintain.
3	Too much engine oil is filled into speed regulator, extending and retracting of centrifugal weight is blocked and sensitivity is reduced because of damping action of oil fluid.	Check if amount of engine oil in oil pan is too much and lubricating oil return pipe of speed regulator is blocked or not, and have it cleaned and replaced when necessary.
4	Various connecting points of speed regulator are worn excessively, contact is loose and clearance increases. When speed of engine changes, all clearances shall be eliminated in turn under centrifugal thrust of flyweight, and then fuel supply adjusting rack (or shifting fork) is driven to increase or decrease amount of fuel being supplied, in order to delay functioning of speed regulator.	Contact with after-sale service personnel to recalibrate or replace.
5	Injection timing is incorrect, atomization is poor and fuel injection pressure at nozzle is uneven	Check and adjust.

4. Diesel engine cannot reach rated speed

No.	Causes	Troubleshooting
1	Speed display is incorrect	Inspect and correct with hand tachometer or

		digital tachometer.
2	Speed sensor malfunctions	Contact with after-sale service personnel to maintain or replace.
3	Fuel supply system is blocked	Check if fuel supply pipe or fuel filter is blocked. If necessary, replace it.
4	There is water in diesel	Replace fuel and add oil-water separator
5	Adjustment of throttle control lever is improper	Check travel of accelerator

5. Voltage of the Gen-set is abnormal

No.	Causes	Troubleshooting
1	There is no voltage during starting of the Gen-set	
	The Gen-set does not reach Rated speed	Adjust throttle control handle of engine until it reaches to Rated speed
	Remanence voltage is low	Magnetize (as shown below)
	Other reasons	Check alternator and AVR as per procedures of excitation separation (as shown below)
2	Voltage is unstable in loaded or no-load operation	
	Speed is unstable	Adjust speed regulator
	AVR stability setting is incorrect	Adjust AVR stability potentiometer of engine (as per the method introduced in Chapter 3)
3	Voltage is too high in loaded or no-load operation	
	Speed of the Gen-set is too high	Reduce speed of the Gen-set to 1500~1560r/min
	Power factor is leading	Capacitive load is too high
4	Voltage under no load is too low	
	Speed is too low	Adjust speed of the Gen-set to 1530~1560r/min
	Terminal 1-2 of AVR (or 6-7 of KRS440) is not shorted	Connect terminal 1-2 (or 6-7) of AVR in short
5	Voltage under load is too low	
	Speed is too low	Adjust speed of the Gen-set to about

		1,500r/min
	UFRO setting	Reset UFRO as shown below
	Other reasons	Check alternator and AVR as shown below according to procedures of excitation separation test method

5.1 Inspection of Remanence Voltage

Remove AVR cover plate, and wires (F1 and F2, or F+ and F-) of excitation stator (magnetic field) when the Gen-set is still;

Start the Gen-set and measure voltage between AVR and terminal of main stator (armature) of alternator. AS440 and AS480: terminal 7-8, SE350: terminal 3-4;

Stop the Gen-set and connect wires (F1 and F2, or F+ and F-) of excitation stator (magnetic field) to the AVR outlet box. If the measured voltage is more than 5V, the alternator should run normally.

If the measured voltage is less than 5V, execute the following steps:

Use 12V DC current, and connect the terminal of AVR (F2 if AS440, KRS440 or AS480 is used, or F- if SE350 or BE350 is used) to the negative electrode, as shown in Figure 10-1.

Note: diode in the figure below must be used to protect AVR against damage.

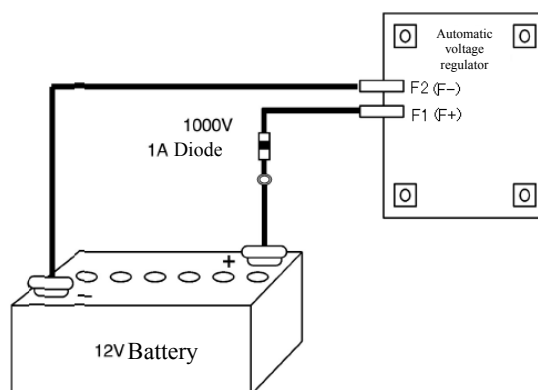


Figure 10-1 Schematic diagram of magnetizing

Note: if the storage battery of Gen-set is used for magnetizing, the neutral line of main stator of alternator shall not be grounded.

Restart the Gen-set and record output voltage of main stator, which shall be close to rated voltage, or voltage between terminals below of AVR shall be 170~250V; AS440 and AS480: terminal 7-8; SE350: terminal 3-4.

Stop the Gen-set. Disconnect the battery from terminals F1 and F2 if AS440, KRS440 or AS480 is used, or terminal F+ and F if SE350 and BE350 is used. Restart the Gen-set, the alternator shall run normally. If there is no voltage, the alternator or AVR line may have problems. Please inspect the winding, rotating diode and AVR of

Gen-set according to procedures of excitation separation test.

5.2 Under Frequency Roll Off (UFRO)

AVR is connected to an under frequency protective circuit. Its voltage/frequency characteristic is shown in Figure 10-2.

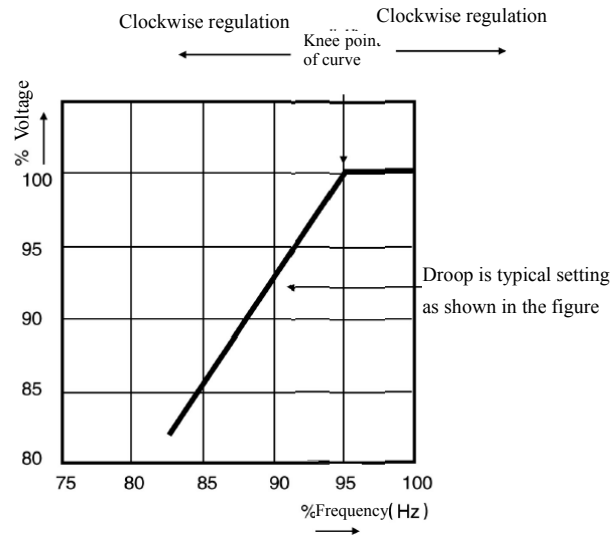


Figure 10-2 Characteristic of UFRO low frequency protection

UFRO control potentiometer is used to set the knee point.

Inappropriate setting will lead to the following consequences:

A light emitting diode (LED) on the top of UFRO control potentiometer is on with load.

Voltage regulation factor is low with load, i.e. the alternator operation curve falls on the oblique line of characteristic curve.

Clockwise rotation will reduce frequency at knee point and turn off light emitting diode. The optimal setting should ensure that when frequency is below the normal range, i.e. frequency of 50Hz alternator is 47Hz and that of 60Hz alternator is 57Hz, the indicator light will be on.

5.3 Procedures of Excitation Separation Test

Inspect winding, rotating diode and AVR of alternator in the corresponding procedure below.

Disconnect wires F1 and F2 (or F+ and F-) of excitation stator (magnetic field) from AVR, and

supply power to F1 and F2 (or F+ and F-) with a 12V DC power source.

Start the Gen-set and operate at rated speed.

Measure voltage at primary output terminals U, V and W;

5.3.1 Voltage Balance of Primary Output Terminal

- 1) If the measured voltage is generally balanced with the unbalance index within 1% and within $\pm 10\%$ of rated voltage of alternator, all excitation windings, main windings and main rotating diodes are sound, and AVR or transformer control may have problems. Test AVR according to the following procedures:
- 2) Remove lead of magnetic field from terminals F1 and F2 (or F+ and F-) of AVR;
- 3) Connect a 60W, 240V bulb between terminals F1 and F2 (or F+ and F-) of AVR;
- 4) Rotate voltage control potentiometer on AVR clockwise to the end;
- 5) Connect 12V1.0A DC power source to F1 and F2 (or F+ and F-) of lead of magnetic field. Note that positive electrode is connected to F1 (F+);
- 6) Start the Gen-set and operate at rated speed;
- 7) Inspect whether the deviation of output voltage of Gen-set is within $\pm 10\%$ of rated voltage.

Voltage on the terminal 7-8 of AVR (or terminal 3-4 of SE350) shall be 170-250V. If output voltage of alternator is normal while that on terminal 7-8 (or terminal 3-4 of SE350) is too low, inspect the connection between auxiliary lead and main terminal.

The bulb between F1 and F2 (F+ and F- of SE350) shall be continuously on. Rotate “voltage regulation” control potentiometer to the end, and the light on AVR plate shall be off or dim.

If the light on AVR plate is on, it indicates that AVR has been damaged and shall be replaced.

Note: rotate “voltage regulation” control potentiometer counter-clockwise to the end after the above test.

- 1) If the voltage is balanced but too low, main excitation winding or rotating diode may have problems. Please execute the steps below to identify the problem:

Rectifier diode

The diode on main rectifying component can be measured with multimeter. Disconnect the flexible conductor connected to each diode at terminal, and measure its forward and reverse resistance. Sound diode shall have very high (infinite) reverse resistance and very low forward resistance. The damaged diode takes on fullscale deflection or reading is infinite both in forward and reverse directions when measured at 10000Ω.

When a sound diode is measured with electronic digital meter, one reading will be low and the other reading will be high.

Replace the damaged diode

The rectifying component is installed on two plates with positive and negative electrodes. The main rotor is connected to the rectifying component through the two plates. Each plate is equipped with 3 diodes. The negative plate is equipped with reverse biased diode, and positive plate with forward biased diode. Note that polarity of diode installed onto corresponding plate must be correct. Good mechanical and electrical connection shall be guaranteed for diode installed onto plate. The diode must be installed securely, but not too tightly. The recommended tightening torque is 4.06-4.74N•m.

Surge suppressor

Surge suppressor is a metal oxide varistor connected to the diode with two rectifying plates to prevent instantaneous reverse voltage in winding from damaging the diode. Without polarity, this device shows an actual infinite reading in both forward and reverse directions when measured with an ordinary ohmmeter. Its damage can be detected as signs of breakage can be found when it is damaged due to short circuit. It shall be replaced if damaged.

Main excitation winding

If output voltage in excitation separation test is still too low after adjustment and replacement of rectifying component, inspect the winding of main rotor, excitation stator and rotor, one of which must have problems. The resistance of excitation stator can be measured at terminals F1 and F2 (F+ and F- of SE350). Excitation rotor is connected to 6-bolt (diode) terminal. The winding of main rotor is connected to two rectifying plates. Corresponding lead must be disconnected before reading.

5.3.2 Voltage Imbalance of Primary Output Terminal

Voltage imbalance shows that main stator winding or main cable connected to circuit breaker may have problems. Note: during excitation, fault of stator winding and main cable may significantly increase the load of engine. Disconnect the main cable and leads of winding, U1-U2, (U5-U6), V1-V2, (V5-V6), W1-W2, (W5-W6), to separate the windings.

Measure phase-to-phase and phase-to-ground insulation resistance.

Imbalanced or incorrect winding resistance and/or too low insulation resistance to ground indicates that stator coil must be replaced.

1. Insufficient output power of Gen-set

Serial number	Cause	Elimination method
1	Combustion of combustible mixture is affected in cold state of diesel engine.	Normal phenomenon. The diesel engine can only be loaded in hot state.
2	Load power is more than rated power of Gen-set.	Reduce load or select Gen-set of higher rated power.
3	Air is thin due to too high temperature or altitude.	Consult salesmen about correcting power of Gen-set.
4	Air leakage of air intake system	Find out the fault point to repair or replace.
5	Intake manifold is blocked.	Clean intake manifold, and replace it if necessary.
6	Fault of air filter	Clean air filter, and replace it if necessary.
7	Exhaust pipe is blocked.	Clear carbon deposit in the exhaust manifold, and replace it if necessary.
8	Silencer is blocked.	Clear carbon deposit in the silencer, and replace it if necessary.
9	The temperature of diesel engine is too high, which reduces aeration rate of cylinder and makes combustion incomplete.	Inspect operation of cooling system and repair.
10	Viscosity of machine is too high, which increases running resistance of diesel engine and power consumption.	Clean the lubrication system, and replace the machine oil with that of appropriate trademark as required in instructions.
11	Resistance of crankshaft dipped in machine oil is great due to too much machine oil in oil pan.	Discharge surplus machine oil to make machine oil level in oil pan between high and low levels of dipstick.
12	Exhaust gas turbocharger is blocked or	Clean exhaust gas turbocharger, and

	impeller is damaged.	replace it if necessary.
13	Compression pressure of cylinder is insufficient due to piston ring scuffing.	Replace the piston ring.
14	Leakage of compressed air is caused by seal leakage of intake/exhaust valve.	Contact with after-sales service personnel to repair or replace.
15	Valve spring is damaged, making it difficult for the valve to return.	Contact with after-sales service personnel to repair or replace.
16	Valve leaks due to incorrect clearance.	Adjust valve clearance.
17	Cylinder gasket is damaged, causing air leakage of joint surface between cylinder head and engine body.	Replace the cylinder gasket.
18	Fuel supply advance angle is inaccurate.	Contact with after-sales service personnel to adjust it.
19	Diesel filter is blocked.	Conduct regular maintenance as required in instructions.
20	Oil circuit is blocked.	Inspect and clean, and replace if necessary.
21	Air in the oil circuit causes too great fluctuation of injection pressure.	Discharge air in low pressure and high pressure oil circuits with method in instructions.
22	There is water in oil.	Replace oil, and install oil-water separator.
23	Matching parts of injector are damaged or suffer from poor atomization.	Contact with after-sales service personnel to repair or replace.
24	Oil supply of fuel injection pump is insufficient or uneven.	Contact with after-sales service personnel to repair or replace.
25	Maximum oil supply limit screw of fuel injection pump is adjusted inappropriately.	Adjust high-speed limit screw.
26	Oil supply of oil pump is insufficient.	Contact with after-sales service personnel to repair or replace.

2. Abnormal noise or vibration of diesel engine in operation

Serial number	Cause	Elimination method
1	The oil is injected untimely or oil supply of cylinders is uneven, causing clear and rhythmic knocking sound of metal in the cylinder, which is particularly intense in start-up or at low speed.	Adjust fuel supply advance angle or evenness of oil supply.
2	Slight rhythmic knocking sound is made due to too big clearance of intake/exhaust valve.	Adjust valve clearance.
3	The diesel engine hasn't been warmed up before increasing the load, so knocking sound is made due to too big clearance between piston and cylinder	Remove the load, switch on and load the Gen-set after it changes into hot state in idle

	liner.	running.
4	Knocking sound is made due to too serious wear and tear of piston, piston ring and cylinder liner.	Replace the corresponding part.
5	Knocking sound can be heard along the whole engine body due to too serious wear and tear of journals and bearing bushes of crankshaft.	Repair or replace the bearing.
6	The valve hits the top of piston due to too small clearance of intake/exhaust valve or incorrect timing of intake/exhaust.	Adjust valve clearance or timing.
7	Individual cylinder doesn't work to intensify vibration of diesel engine.	Inspect fuel system and troubleshoot.
8	Valve is broken (sudden and violent crash is made due to damage to valve lock clamp, falling of valve or breakage of piston)	Immediately stop for overhaul.
9	Squealing of air leakage is made at cylinder head gasket.	Inspect bolt pretightening force of cylinder head, and replace the cylinder gasket if necessary.
10	Knocking sound due to too serious wear and tear of gears	Inspect and replace them.
11	Fixing bolt of the diesel engine is loose or damaged, which intensifies vibration.	Tighten or replace the bolt.
12	Diesel engine is not concentric with alternator, which intensifies vibration.	Inspect whether chassis is deformed, and shock absorber is disabled, and replace it if so.

3. Unsteady running of diesel engine

Serial number	Cause	Elimination method
1	Individual cylinder is ignited intermittently, which makes oil erupt too violently thereby knocking the cylinder.	Inspect fuel system.
2	Oil quantity and injection time of injection pumps are inconsistent.	Inspect and adjust.
3	There is air in fuel system.	Discharge air in the fuel system with method in instructions.
4	There is water in fuel system.	Discharge water in the fuel system with fuel filter, or replace the fuel.
5	Timing gear moves forward and backward.	Inspect fastening of gears.
6	Fault of governor	Contact with after-sales service personnel for repair.

4. Overspeed of engine

Serial number	Cause	Elimination method
1	Damage to injection pump plunger or delivery valve seat, deformation of plunger bushing due to too large tightening torque, impurity in clearance of plunger pair, too thin gasket on positioning bolt of plunger bushing or jamming of plunger bushing due to too long bolts, etc. during repair or assembly can make injection pump plunger inflexible or stuck at the position of maximum oil supply.	Contact with after-sales service personnel to recalibrate or replace the injection pump.
2	Fixing screw of gear ring for adjusting oil flow of injection pump plunger gets loose, causing plunger to get out of control.	Contact with after-sales service personnel to fasten the loose screw.
3	Bulb of adjusting arm of injection pump plunger or rack is not in the groove of control fork, which keeps the plunger at maximum oil level.	Contact with after-sales service personnel for repair.
4	Oil supply control rack and moving parts of governor suffer from clamping stagnation, which disjoints oil flow control rack and pull rod of governor.	Contact with after-sales service personnel to repair or replace.
5	Lubricating oil in governor is too much, viscous or dirty, which prevents the heavy hammer from being timely thrown off when speed rises, and pull rod or rack from controlling the governor.	Inspect whether machine oil in oil pan is too much, and lubricating oil return line of the governor is blocked. Clean or replace if necessary.
6	Fuel injector spring is too weak or broken, which makes injection pressure too low, leading to excess fuel in cylinder.	Contact with after-sales service personnel to repair or replace.
7	Pin roll of flyball of governor is broken and falls off, which makes the flyball get detached.	Contact with after-sales service personnel to repair or replace.

5. Low lubricating oil pressure

Serial number	Cause	Elimination method
1	Problems of oil pressure gauge or controller, oil pressure sensor	Correct oil pressure gauge and sensor, and replace them if necessary.
2	Machine oil is insufficient.	Fill machine oil.
3	Viscosity of machine oil decreases due to high temperature, which reduces oil	Clean cooling system and oil cooler.

	pressure.	
4	Leakage of lubricating oil circuit of diesel engine	Replace the leaking part.
5	Blocking of oil filter	Clean the oil filter, and replace filter element if necessary.
6	Suction filter of oil pump is blocked.	Clean the suction filter.
7	The machine oil goes bad or is mixed with other liquids, which decreases viscosity and thereby reducing oil pressure.	Replace machine oil with method in instructions.
8	Oil pump capacity is insufficient.	Replace oil pump.
9	Fit clearance between crankshaft and bearing is too big due to wear and tear after long-term use.	Replace main bearing and connecting rod bearing.

6. High coolant temperature

Serial number	Cause	Elimination method
1	Coolant is insufficient.	Fill coolant to 5cm below the tank cover.
2	Fault of water pump	Contact with after-sales service personnel to repair or replace.
3	Fault of thermostat	Contact with after-sales service personnel to repair or replace.
4	Hose is damaged.	Replace the connecting hose.
5	Radiator is blocked.	Clean the radiator. (See Chapter 9 for method)

7. Fuel consumption is too high

Serial number	Cause	Elimination method
1	Fault of fuel injector	Contact with after-sales service personnel to repair or replace.
2	Poor quality of diesel	Select fuel of appropriate trademark.
3	Air intake system is blocked.	Clean intake manifold and air filter, and replace them if necessary.
4	Exhaust back pressure is too high.	Clear the carbon deposit in exhaust manifold and silencer.
5	Turbocharger is dirty.	Clean the turbocharger.
6	Oil supply system is blocked.	Inspect and replace fuel filter, sealing gasket and oil supply line.
7	Oil supply system leaks.	Find out the leaking point for repair and replacement.
8	Fault of injection pump	Contact with after-sales service personnel to recalibrate or replace.

8. Lubricating oil consumption is too high

Serial number	Cause	Elimination method
1	Wrong lubricating oil trademark	Use lubricating oil of correct trademark.
2	Piston ring, piston or cylinder liner suffers from serious wear and tear, which makes machine oil enter combustion chamber.	Replace piston ring, piston or cylinder liner.
3	Valve rod and guide suffer from serious wear and tear, which makes machine oil enter combustion chamber.	Replace valve rod and guide.
4	There is too much machine oil in oil pan, which makes machine oil enter combustion chamber.	Discharge surplus machine oil.

9. The Gen-set can not be stopped

Serial number	Cause	Elimination method
1	Poor contact, open circuit	Eliminate any open circuit/poor contact, inspect whether the contact suffers from oxidation, and clean it if necessary.
2	Fault of wiring of key switch	Inspect wiring of key switch
3	Fault of flameout controller	Repair flameout controller.
4	Blocking of oil return pipe	Inspect whether oil return pipe is blocked, warped or sunken, and replace it if necessary.

Chapter 11 Service Commitment

Dear users:

Welcome to use Weichai products! Thank you for your favor of Weichai products!

In order for correct use and maintenance of the Gen-set, please carefully read instructions for use and maintenance, and operate in strict accordance with relevant provisions. If the diesel engine breaks down, please contact with Weichai repair service center or customer service center as soon as possible. We will provide timely and effective repair service for you.

Weichai Generating Equipment Co., Ltd.

Address: No.197, A, East Fushou Street, High-tech Industrial Development Zone, Weifang, Shandong

Post code: 261001

Website: <http://www.weichaihm.com>

Tel: 400-0536-988

I. Service Concept

Customer satisfaction is our purpose.

II. Service Commitment

The repair service center of our company guarantees to arrive at the site within 3h in the city, 24h in general areas and 48h in remote areas in the service area upon receiving user information and confirming that service is needed (except for force majeure).

III. Principle and Provision of Quality Warranty (“Three Guarantees”)

On the premise that users observe “operating instructions for Gen-set”, our company will be responsible for repairing or replacing the damaged parts for free if the Gen-set is damaged due to poor manufacturing and record is available within 12 months after leaving the factory or 1500h after being put into operation accumulatively. Our company will not compensate for machine faults caused by improper use. But we can provide users with paid technical service and parts to help them promptly solve the problems.